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LTi DRiVES

ServoOne

Operation Manual

Multi-Axis System

DC Axis Controller 565 to 770 V DC

ServoOne _ Energy-efficient multi-axis system

Comprising DC-powered axis controllers and coordinated supply units, the ServoOne multi-axis system offers a high degree of solutions expertise and flexibility. Reduced wiring and shorter installation times are demands which can be easily met, as can the need to conserve resources and minimize cost in operation.

ServoOne Operation Manual
Multi-Axis System DC Axis Controller

ID no.: 1101.20B.2-00

Date: 01/2011

Applicable as from firmware version: *V2.20-01 - Release for field test only!*

The German version is the original of this Operation Manual.

We reserve the right to make technical changes

The content of our documentation was compiled with the greatest care and attention, and based on the latest information available to us.

We should nevertheless point out that this document cannot always be updated in line with ongoing technical developments in our products.

Information and specifications may be subject to change at any time. For information on the latest version please visit http://drives.lt-i.com.

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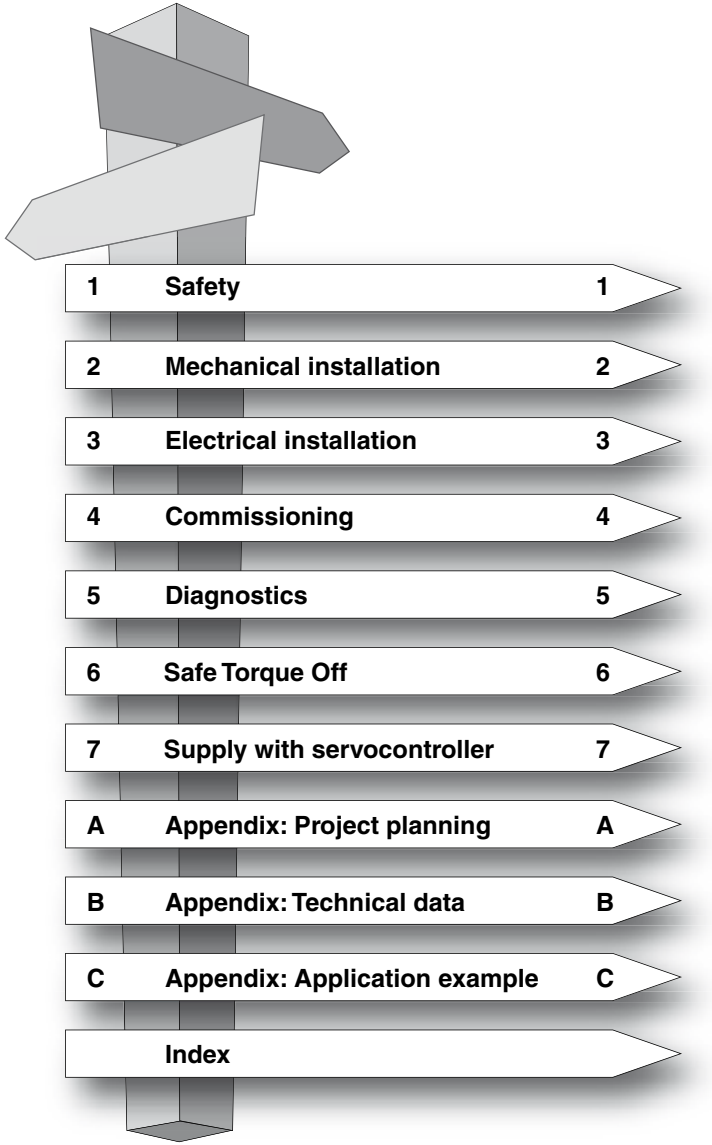
How to use this document

Dear user,

We are happy that you have made a decision in favour of a product from LTi DRiVES. In order to be able to start using your new device quickly and without problems, we ask you kindly to read this Operation Manual thoroughly beforehand.

Step	Action	Comment
1.	This Operation Manual will enable you to install and commission the DC axis controller very quickly and easily.	Quick-start guide
2.	Simply follow the step-by-step tables in the various sections.	And away you go!



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Documentation on the ServoOne multi-axis system

Documents directly required to construct and operate the multi-axis system

Document	Contents	ID no.
ServoOne Supply Unit Operation Manual	Mechanical installation, Electrical installation, Safety, Specification	1101.01B.x
ServoOne DC Axis Controller Operation Manual	Mechanical installation, Electrical installation, Safety, Specification	1101.00B.x
ServoOne Single-Axis System Operation Manual	Mechanical installation, Electrical installation, Safety, Specification	1100.00B.x

Information on the complete ServoOne family

Document	Contents	ID no.
ServoOne Brochure	Key features, user-friendliness, ServoOne junior product overview, ServoOne single-axis and multi-axis system	0920.0045
ServoOne Safety Brochure	Safe Motion - Safety engineering: Configuration, programming, validation	0920.0044
ServoOne System Catalogue	Overview and ordering instructions for: ServoOne junior, ServoOne single-axis system, ServoOne multi-axis system, variants and accessories	1100.04B.x

Further documentation relating to the ServoOne family

Document	Contents	ID no.
ServoOne Application Manual	Description of the base software for the single- and multi-axis systems and the ServoOne junior	1100.02B.x
CANopen/EtherCAT User Manual	Description and parameter setting of the ServoOne on the CANopen or EtherCAT field bus system	1100.08B.x old 1108.08B.x new
SERCOS II User Manual	Description and parameter setting of the ServoOne on the SERCOS II field bus system	1100.09B.x old 1108.09B.x new
SERCOS III User Manual	Description and parameter setting of the ServoOne on the SERCOS III field bus system	1108.06B.x new
PROFIBUS-DPV User Manual	Description and parameter setting of the ServoOne on the PROFIBUS-DPV field bus system	1100.07B.x old 1108.07B.x new

Order code

The order designation indicates the design variant of the drive controller supplied to you. For details on the order code refer to the ServoOne system catalogue.

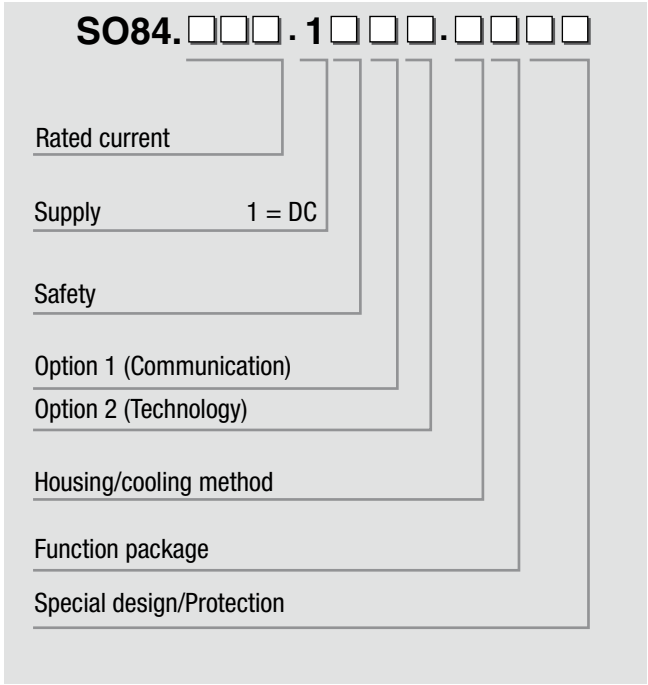

Figure 0.1 Order code – ServoOne multi-axis system DC axis controller

Rating plate

On rating plates of the ServoOne drive units you will find the serial number, from which you can identify the date of manufacture based on the following key. You will find details of the rating plate's location on the ServoOne starting on page 20.

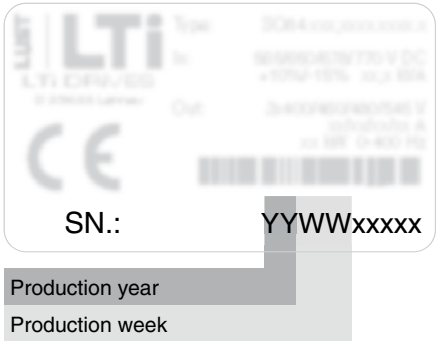

Figure 0.2 Hardware rating plate – ServoOne multi-axis system DC axis controller

Supply package

The supply package includes:

- ServoOne drive unit
- Ready made-up cables
- Shield (optional)
- Product DVD

Pictograms

To provide clear guidance, this Operation Manual uses pictograms. Their meanings are set out in the following table. The pictograms always have the same meanings, even where they are placed without text, such as next to a connection diagram.

Warning symbols (see also section 1.1)	
	ATTENTION! Misoperation may result in damage to the drive or malfunctions.
	DANGER FROM ELECTRICAL TENSION! Improper behaviour may endanger human life.
	DANGER FROM ROTATING PARTS! Drive may start up automatically.
Hints & Tips	
	NOTE: Useful information or reference to other documents
	STEP: Action in a sequence of multiple actions.

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Space for your own notes

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1. Safety

1.1 For your safety

The instructions set out below should be read through prior to initial commissioning in order to prevent injury and/or damage to property. The safety instructions must be followed at all times.

1.1.1 Read the Operation Manual first!

	Read the Operation Manual first! • Follow the safety instructions! • Refer to the user information!
	Electric drives are dangerous: • Electrical voltages 230 V AC / 320 V DC to 480 V AC / 770 V DC **Dangerously high voltages ≥ 50 V may still be present 10 minutes after the power is cut (capacitor charge). So check that the power has been cut!** • Rotating parts • Hot surfaces
	Protection against magnetic and/or electromagnetic fields during installation and operation. • Persons fitted with heart pacemakers, metallic implants and hearing aids etc. must not be allowed access to the following areas: – Areas where drive systems are installed, repaired and operated. – Areas where motors are installed, repaired and operated. Motors with permanent magnets pose a particular hazard. NOTE: If it is necessary to access such areas, suitability to do so must be determined beforehand by a doctor.
	Your qualification: • In order to prevent personal injury and damage to property, only personnel with electrical engineering qualifications may work on the device. • The said qualified personnel must be familiar with the contents of the Operation Manual (cf. IEC 364, DIN VDE 0100). • Awareness of national accident prevention regulations (e.g. BGV A3 in Germany).
	During installation observe the following instructions: • Always comply with the connection conditions and technical specifications. • Comply with the standards for electrical installations, such as regarding wire cross-section, protective conductor and ground connections. • Do not touch electronic components and contacts (electrostatic discharge may destroy components).

Table 1.1 Safety instructions

1.1.2 Warning symbols used

The safety instructions detail the following hazard classes.
The hazard class defines the risk posed by failing to comply with the safety notice.

Warning symbols	General explanation	Hazard class to ANSI Z 535
	ATTENTION! Misoperation may result in damage to the drive or malfunctions.	Serious injury or damage to property may occur.
	DANGER FROM ELECTRICAL TENSION! Improper behaviour may endanger human life.	Death or serious injury will occur.
	DANGER FROM ROTATING PARTS! Drive may start up automatically.	Death or serious injury will occur.

Table 1.2 Explanations of warning symbols

1.2 Intended use

ServoOne drive controllers are components for installation into stationary electric systems or machines.

When installed in machines the commissioning of the drive controller (i.e. start-up of intended operation) is prohibited, unless it has been ascertained that the machine fully complies with the provisions of the Machinery Directive 2006/42/EC; compliance with EN 60204 is mandatory.

Commissioning (i.e. start-up of intended operation) is only permitted when strictly complying with the EMC Directive (2004/108/EC).

CE The ServoOne DC axis controller conforms to the Low Voltage Directive 2006/95/EC.

The axis controllers comply with the requirements of the harmonized product standard EN 61800-5-1:2008.

If the axis controller is used for special applications, such as in areas subject to explosion hazard, the required standards and regulations (e.g. in the Ex zone EN 50014, "General provisions" and EN 50018 "Flameproof housing") must always be observed.

Repairs may only be carried out by authorized repair workshops. Unauthorized opening and incorrect intervention could lead to death, physical injury or material damage. The warranty provided by LTi DRiVES would thereby be rendered void.

NOTE: Deployment of the axis controllers in non-stationary equipment is classed as non-standard ambient conditions, and is permissible only by special agreement.

1.3 Responsibility

Electronic devices are fundamentally not fail-safe. The company setting up and/or operating the machine or system is itself responsible for ensuring that the drive is rendered safe if the device fails.

In the section on "Electrical equipment of machines" the standard EN 60204-1/DIN VDE 0113 "Safety of machines" stipulates safety requirements for electrical controls. They are intended to protect personnel and machinery, and to maintain the function capability of the machine or system concerned, and must be observed.

The function of an emergency off system does not necessarily have to cut the power supply to the drive. To protect against danger, it may be more beneficial to maintain individual drives in operation or to initiate specific safety sequences. Execution of the emergency stop measure is assessed by means of a risk analysis of the machine or plant, including the electrical equipment in accordance with EN ISO 14121 (previously DIN EN 1050), and is determined in accordance with EN ISO 13849-1 (previously EN 954-1), "Safety of machines - Safety-related parts of controls" by selecting the circuit category.

2. Mechanical installation

2.1 Notes for installation

ATTENTION!

- **During installation,**
  please be sure to avoid ...
  – drill chippings, screws or other foreign bodies dropping into the device;
  – penetration of damp into the device.
- **Switch cabinet**
  The device is solely intended for installation in a stationary switch cabinet. The switch cabinet must as a minimum provide IP4x protection. When using the STO (Safe Torque OFF) safety function, according to EN ISO 13849-2 the switch cabinet must have IP54 protection or higher.
- **Immediate vicinity**
  – The drive controllers must not be installed in areas where they would be permanently exposed to vibrations. For more information refer to table B.20 in the appendix.
  – The device heats up in operation and at the heat sink may reach temperatures of up to 100 °C. Pay attention to this in relation to adjacent components.

NOTE: For installation of the drive controller within a ServoOne multi-axis system, be sure also to refer to the Operation Manual for the supply unit or the supplying AC single-axis controller.

The layout and installation of the DC axis controllers and supply units is subject to the following basic rules:

- **Pollution**
  Maximum pollution severity 2 to EN 60664-1. Further information on environmental conditions can be found in table B.18 in the appendix.
- **Effective EMC installation**
  To attain the best result for effective EMC installation you should use a well grounded chromated or galvanized backing plate. If backing plates are varnished, remove the coating from the contact area. The devices themselves have an aluminium rear panel (BG1 to BG4) or a rear panel made of aluminized/galvanized sheet steel (BG5, BG6a).
- **Cooling**
  Cooling air must be able to flow through the device without restriction. For mounting in switch cabinets with convection (= heat loss is discharged to the outside via the cabinet walls), always fit an internal air circulation fan.
- **End-to-end mounting and alignment**
  – Devices with different housing variants (wall-mounted and liquid-cooled) can be installed next to each other in any combination, as devices with liquid-cooled housings have a spacer on the rear in place of the heat sink. Consequently, it is possible to connect to devices with wall-mounted housings using the ready made-up DC link cables without additional measures to compensate for differing unit depth.
  – No minimum clearance between the devices is required. Exceptions to this rule are the following wall-mounted devices of size BG6a (see table 2.1). The maximum distance between the devices is dictated by the supplied ready made-up cables, and is 1.5 mm (except BG6a).
  – In the case of end-to-end mounting, the axis controllers must be sorted in ascending **or** descending order of power.
  – A vertical offset of 18.5 mm must be allowed between the top fixing screws for devices of sizes BG1 to BG5 and devices of size BG6a (see figures 2.1 and 2.6).

If you need more details on installation please contact the LTi Helpline (see page 50).

2.2 DC axis controller installation Wall-mounted housing

Step	Action	Comment
1.	Arrange the devices starting from the supply unit to the right and/or left sorted in descending order of power output, in order to minimize thermal influences. In the case of supply unit BG5, align all ServoOne DC devices in a line along the top edge of the unit (see figure 2.1). In the case of supply unit BG6a, align all ServoOne DC devices 18.5 mm lower (see figure 2.2).	This is necessary in order to execute the DC link using the ready made-up cables. For specified mounting clearances see table 2.1.
2.	Mark out the position of the tapped holes on the backing plate. Drill holes in the backing plate and cut a thread for each fixing screw.	Take account of the bend radius of the connecting cables! For hole pitch and dimensional drawings see figures 2.3 and 2.4.
3.	Mount the DC axis controllers vertically in a row on the backing plate.	The contact area must be metal-lically bright. For the DC power supply use the supplied ready made-up DC link cables.
	Continue with the electrical installation in section 3.	

Multi-unit layout with air cooling

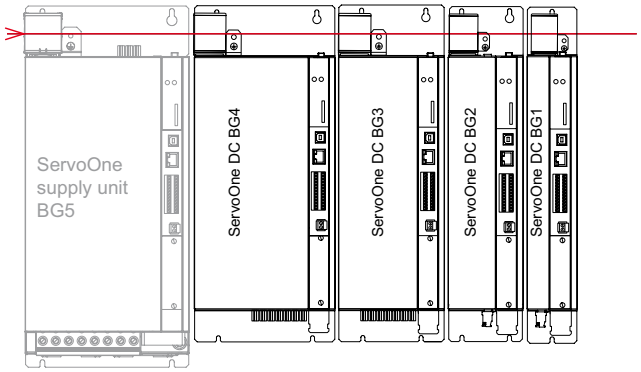

Figure 2.1 Row of air-cooled DC axis controllers adjacent to supply unit BG5 (example)

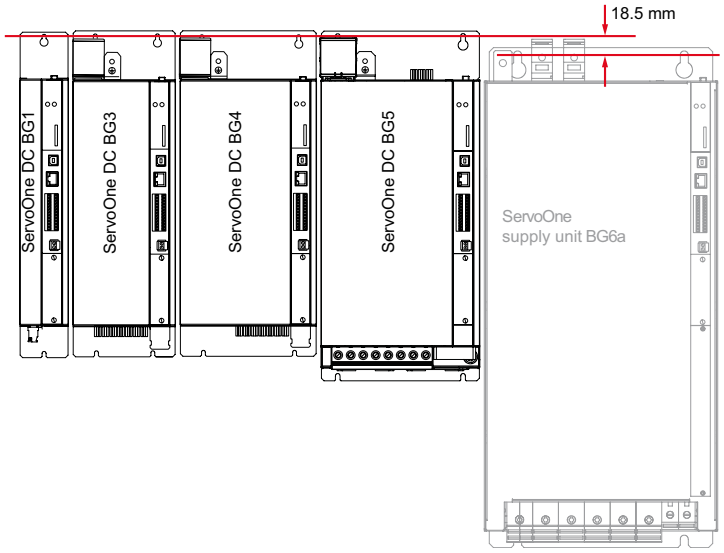

Figure 2.2 Row of air-cooled DC axis controllers adjacent to supply unit BG6a (example)

Dimensions, wall-mounted housing

ServoOne	BG1	BG2	BG3	BG4	BG5	BG6a
	SO84.004.1xxx.0 SO84.006.1xxx.0	SO84.008.1xxx.0 SO84.012.1xxx.0	SO84.016.1xxx.0 SO84.020.1xxx.0	SO84.024.1xxx.0 SO84.032.1xxx.0	SO84.045.1xxx.0 SO84.060.1xxx.0 SO84.072.1xxx.0	SO84.090.1xxx.0 SO84.110.1xxx.0 SO84.143.1xxx.0 SO84.170.1xxx.0
Weight [kg]	3.4	4.9	6.5	7.5	13	32
B (width)	58.5	90	130	171	190	280
H (height) [1]	295				345	540
T (depth) [1]	224				240	322
A	29.25	50	80	120	150	200
C	382				406.5	581
C1	5				6	10
D	4.8				5.6	9.5
E	Direct end-to-end mounting, max. 2					40 [2]
F [3]	≥ 100		≥ 150		≥ 180	
G [3]	≥ 270				≥ 300	≥ 500
H1	392				418.5	600
H2	38.5				15	20
Screws	2 x M4	4 x M4			4 x M5	4 x M8

1) Without terminals/connectors
2) Mounting clearance of BG6a to other BG6a units
3) The bend radius of the connecting cables must be taken into account
All dimensions in mm

Table 2.1 Dimensions, wall-mounted housing

NOTE: The minimum clearance specified in the table applies to devices of the same power output. Arrange devices with different drive power in descending order of power output (e.g. viewed from the left BG4-BG3-BG2-BG1). This minimizes the mutual thermal influence. The supply unit must always be arranged on the side of the most powerful axis controller.

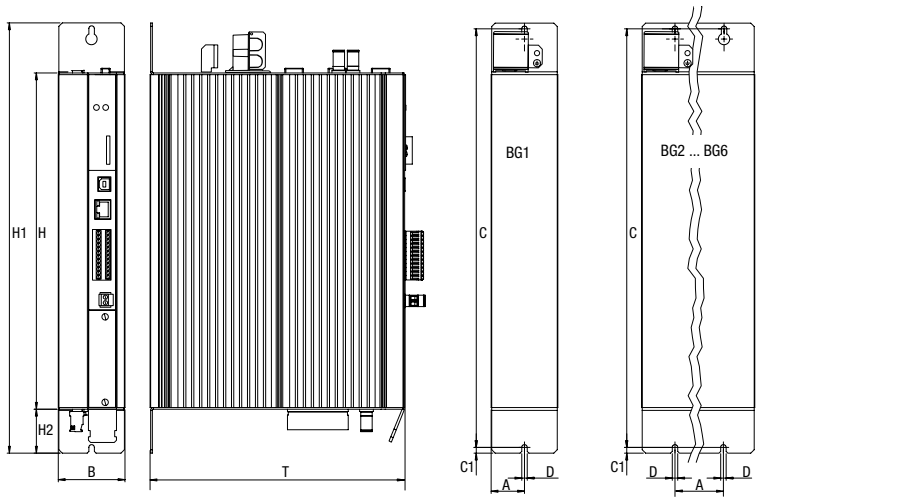

Figure 2.3 Dimensional drawing, wall-mounted housing

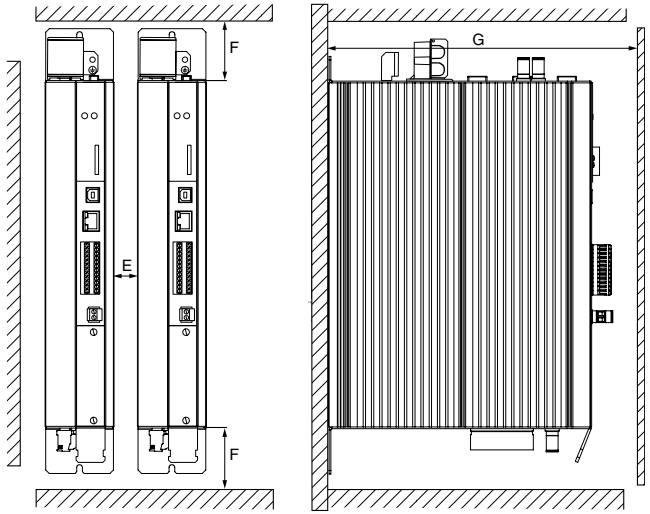

Figure 2.4 Mounting clearance, wall-mounted housing

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2.3 DC axis controller installation Liquid-cooled housing

Step	Action	Comment
1.	Arrange the devices starting from the supply unit to the right and/or left sorted in descending order of power output, in order to minimize thermal influences. In the case of supply unit BG5, align all DC axis controllers in a line along the top edge of the unit (figure 2.5). In the case of supply unit BG6a, align all DC axis controllers 18.5 mm lower (figure 2.6).	This is necessary in order to execute the DC link using the ready made-up cables. For specified mounting clearances see table 2.2.
2.	Mark out the positions of the tapped holes and the pipe socket on the backing plate. Drill holes and cut a thread for each fixing screw in the backing plate.	Take account of the bend radius of the connecting cables! For hole pitch and dimensional drawings see table 2.2, figures 2.7 and 2.8.
3.	Mount the DC axis controllers vertically in a row on the backing plate.	The contact area must be metallically bright. For the DC power supply use the supplied ready made-up DC link cables.
4.	When fitting the hose connections (not supplied) in the pipe sockets, brace with a 22 mm open-ended wrench in order to prevent damage to the device by torsion.	Ensure a perfect liquid-tight connection (e.g. using a Teflon sealing strip)!
	Continue with the electrical installation in section 3.	

Multi-unit layout with liquid cooling

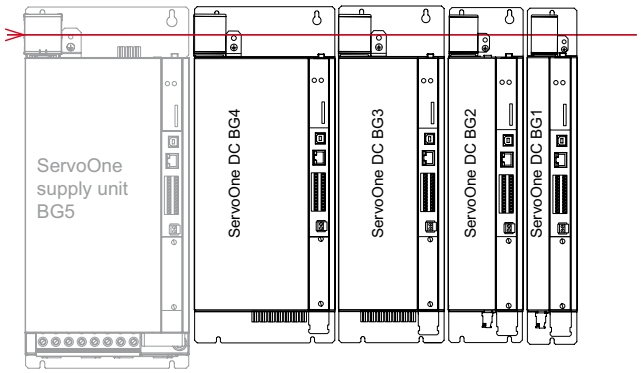

Figure 2.5 Row of liquid-cooled DC axis controllers adjacent to supply unit BG5 (example)

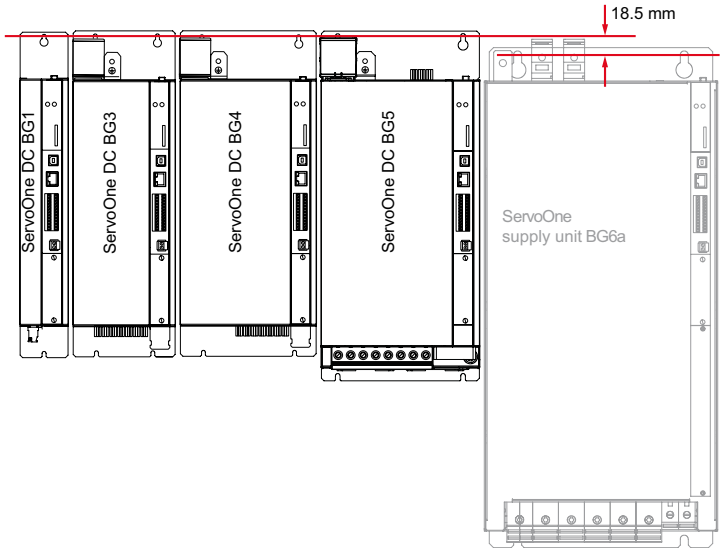

Figure 2.6 Row of liquid-cooled DC axis controllers adjacent to supply unit BG6a (example)

Dimensions, liquid-cooled housing

ServoOne	BG3	BG4	BG5	BG6a
	SO84.016.1xxx.8 SO84.020.1xxx.8	SO84.024.1xxx.8 SO84.032.1xxx.8	SO84.045.1xxx.8 SO84.060.1xxx.8 SO84.072.1xxx.8	SO84.090.1xxx.8 SO84.110.1xxx.8 SO84.143.1xxx.8 SO84.170.1xxx.8
Weight [kg]	6.5	7.5	13	32
B (width)	130	171	190	280
H (height) [1]	295		346.5	540
T (depth) [1]	224		238.5	285
A	80	120	150	200
A1	10	25	40	65
A2	60		70	
C	382		406.5	581
C1	5		6	10
D	4.8		6.5	9.5
D1	48 (hole for pipe socket)			
E	Direct end-to-end mounting, max. 2			
F [2]	≥ 150		≥ 180	
G [2]	≥ 300			≥ 500
H1	392		418.5	600
H2	38.5		15	20
H3	75	70	54	56.5
S [inches]	3/8 (inside thread)			
Screws	4 x M4		4 x M6	4 x M8
T1	74		73.5	

1) Without terminals/connectors
2) The bend radius of the connecting cables must be taken into account
All dimensions in mm

Table 2.2 Dimensions, liquid-cooled housing

NOTE: Arrange devices with different drive power in descending order of power output (e.g. viewed from the left BG4-BG3-BG2-BG1). This minimizes the mutual thermal influence. The supply unit must always be arranged on the side of the most powerful axis controller.

When end-to-end mounting ServoOne controllers together with other devices, you must make sure that the device do not affect one another thermally.

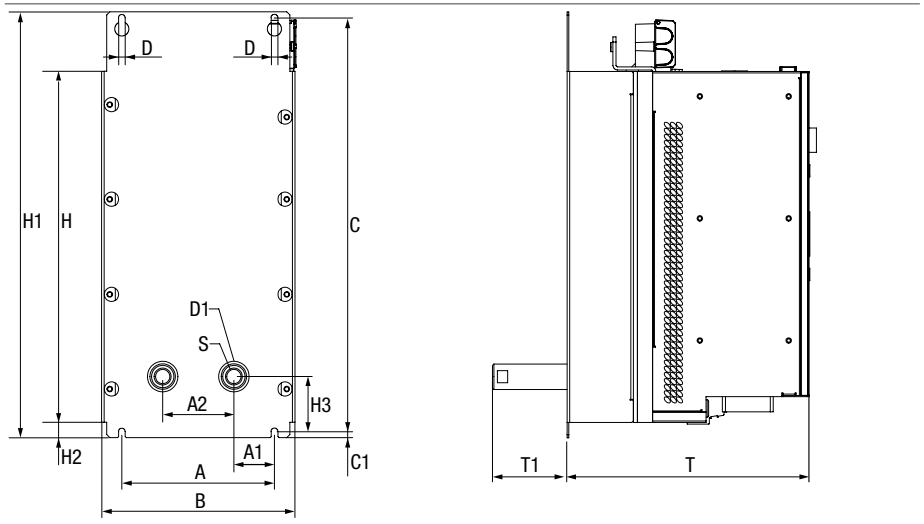

Figure 2.7 Dimensional drawing, liquid-cooled unit

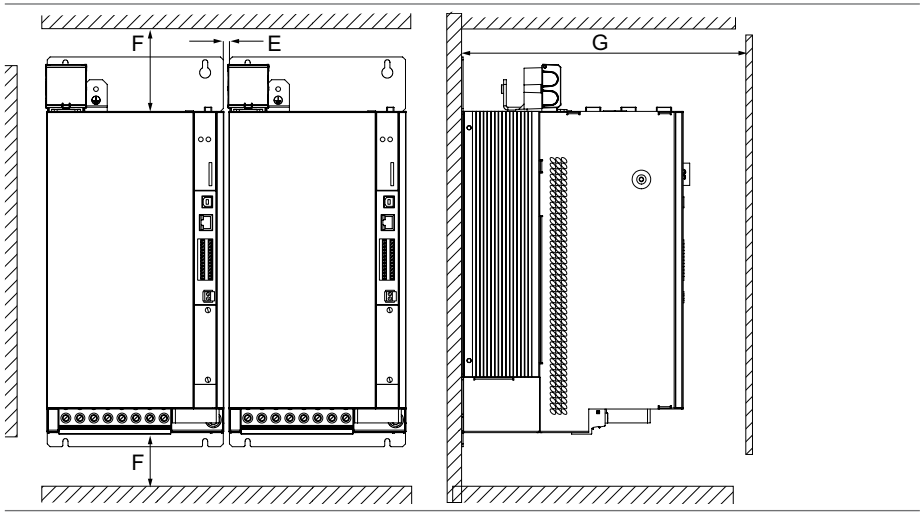

Figure 2.8 Mounting clearance, liquid-cooled unit

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Permissible multi-axis layouts

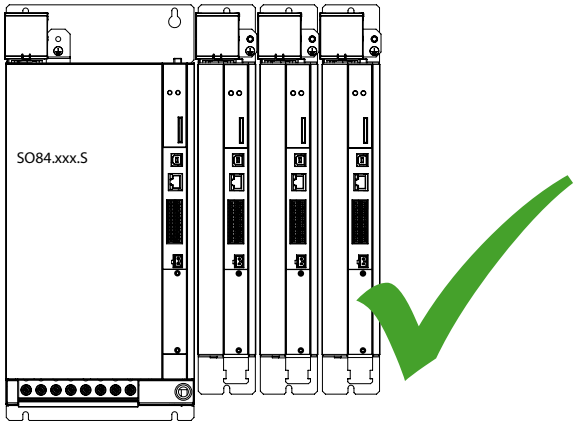

Figure 2.9 Example of a permissible layout: Arrangement of ServoOne DC axis controllers of same size on one side of the supply unit

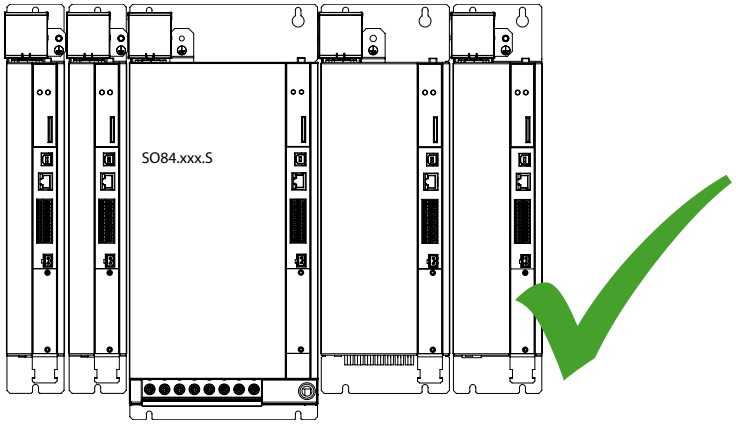

Figure 2.10 Example of a permissible layout: Arrangement of ServoOne DC axis controllers of same size and in descending order of size on both sides of the supply unit respectively

Impermissible multi-axis layouts

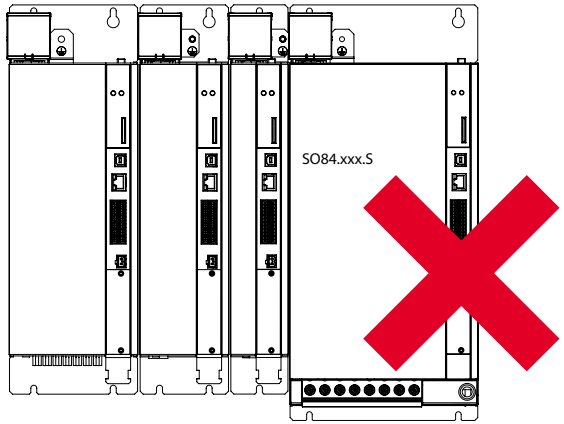

*Figure 2.11 Example of an **impermissible** layout: Arrangement of ServoOne DC axis controllers in ascending order of size*

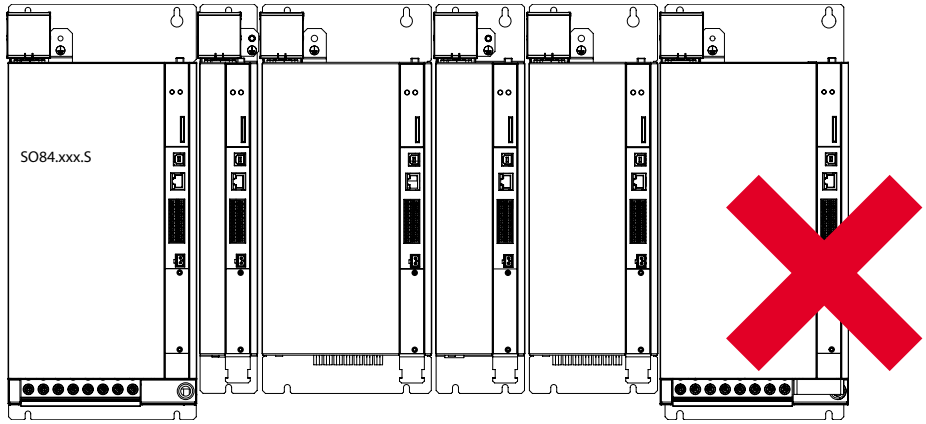

*Figure 2.12 Example of an **impermissible** layout: Arrangement of ServoOne DC axis controllers in ascending and descending order of size*

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3. Electrical installation

3.1 Notes for installation

ATTENTION!

- **Qualified personnel**
  Installation must only be carried out by qualified electricians who have undergone instruction in the necessary accident prevention measures.
- **During installation,**
  please be sure to avoid ...
  – screws, cable residues or other foreign bodies dropping into the device;
  – penetration of damp into the device.

DANGER FROM ELECTRICAL TENSION!

- **Danger to life!**
  – Never wire or disconnect electrical connections while they are live! Disconnect the device from the mains supply (230/400/460/480 V AC or 565/650/678/770 V DC) before working on it. Dangerously high voltages of ≥ 50 V may still be present 10 minutes after the power is cut (capacitor charge). Work on the device must only be carried out when the DC-link voltage has dropped below a residual voltage of 50V (measured on BG1-BG4 at terminals X11 and X12/L- / L+, on BG5 and BG6a on terminals X11 and X12/ZK- / ZK+).
  – Even if the device does not emit any visual or audible signals or show other indications, dangerous voltage may be connected to the device (such as with mains voltage to terminal X11 switched on) and no control supply (+24 V DC on X9, X10)!

NOTE: For installation of the drive controller within a ServoOne multi-axis system, be sure also to refer to the Operation Manual for the supply unit or the supplying AC single-axis controller.

- **Compliance with EMC product standard**
  Commissioning (i.e. starting intended operation) is only permitted when strictly complying with EMC product standard EN 61800-3:2004. The installer/operator of a machine and/or item of plant must provide proof of compliance with the protection targets stipulated in the standard.
- **Cable type**
  – Use shielded mains, motor and signal cables with double copper braiding, providing 60 to 70 % coverage.
  – Always route the motor cable without interruptions and by the shortest route out of the switch cabinet. If a motor contactor or motor choke is used, the component should be directly mounted to the axis controller and the shield of the motor cable should not be stripped too soon.
  – If very large cable cross-sections have to be installed, shielded single wires may also be used instead of shielded cables.

ATTENTION! Use the supplied ready made-up cables for the electrical connections between the devices. If extending the DC link is unavoidable, be sure to comply with the rules set out in section B.5 (page 83). If cables not conforming to the stipulated rules are used, LTi DRiVES can provide no guarantee of stable and safe operation.

- **Cable laying**
  – Lay mains, motor and signal cables isolated from each other. Maintain a minimum clearance of 0.2 metres wherever possible. Use separators as necessary.
  – Always route the motor cable without interruptions and by the shortest route out of the switch cabinet. If a motor contactor or motor choke is used, the component should be directly mounted to the drive controller and the shield of the motor cable should not be stripped too soon.
  – As far as possible route signal cables into the switch cabinet from one side only.
  – Cables of the same circuit must be twisted.
  – Avoid unnecessary cable lengths and loops.
- **Shielding**
  Do not strip the cable shields too soon, and lay them across wide areas both on the component and on the backing plate and PE rail (main ground) of the backing plate.

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- **Grounding**
  The grounding measures of relevance to the drive controller are detailed in section 3.4 on page 24.
- **External components**
  - Place larger consumers near the supply.
  - Contactors, relays, solenoid valves (switched inductors) must be wired with fuses. The wiring must be directly connected to the respective coil.
  - Switched inductors should be at least 0.2 m away from process controlled assemblies.

If you need more details on installation please contact the LTi Helpline (see page 50).

Step	Action	Comment
1.	Identify the terminal assignment applicable to your device.	Section 3.2 for BG1 to BG4 Section 3.3 for BG5 and BG6a
2.	Connect all required input and output units to the control terminals and option interfaces where appropriate.	Section 3.7 Section 3.10 and/or 3.11
3.	Connect the encoder and motor.	Sections 3.12 and 3.13
4.	Connect the protective conductor and the supply voltages using the ready made-up cables (DC-L).	Sections 3.4 and 3.6
5.	Continue with commissioning in section 4.	

3.2 Overview of connections, BG1 to BG4

The following shows the layout, with the corresponding positions of plugs and terminals. To aid orientation, the connectors and terminals are labelled by abbreviations.

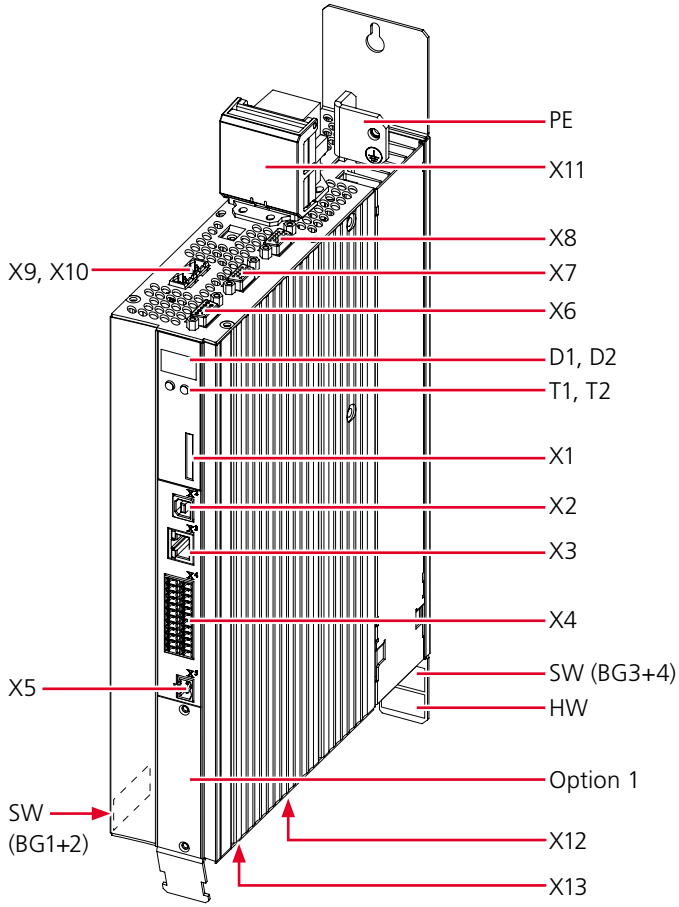


Figure 3.1 Layout, BG1 to BG4 (here: BG1)

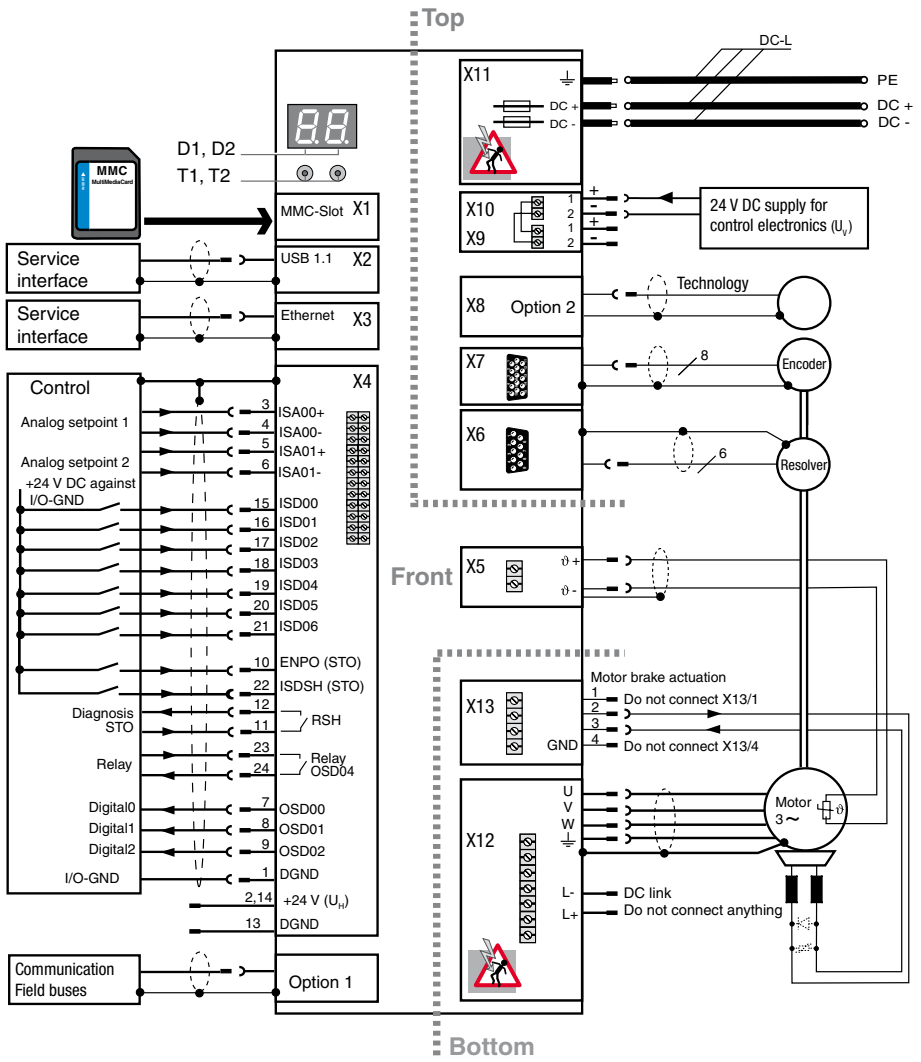


Figure 3.2 Connection diagram, BG1 to BG4

Abbr.	Designation	Function	Page
D1, D2	7-segment display	Device status display	see p.42
T1, T2	Pushbuttons	Service functions	see p.42
X1	Slot for MMC removable storage device	Enables firmware download without PC for example	see p.41
X2	USB 1.1 port	Service interface, Plug & Play connection to PC	see p.31
X3	Ethernet port	Service interface, fast TCP/IP port (RJ45)	see p.31
X4	Control terminals	Relay output diagnosis STO, 7 digital inputs, ENPO, ISDSH, 2 anlog inputs, 3 digital outputs, 1 additional relay output	see p.29
Option 1	Communication	Factory installed module for field buses e.g. SERCOS, PROFIBUS, EtherCAT or CANopen	see p.31
X11	DC connection	Power supply (internally protected)	see p.27
DC-L	DC link cable	Ready made-up cables for DC power supply and protective conductor	see p.83
PE	Protective conductor connection	Connection diagram see section 3.4	see p.24
X9, X10	Connection of control supply U_V	24 V DC supply voltage for control electronics of drive controller	see p.26
X8 Option 2	Technology	Factory installed module e.g for TTL encoder simulation, second Sin/Cos encoder or EnDat 2.1	see p.31
X7	High-resolution encoder interface	Sin/Cos encoder, EnDat 2.1 encoder, Hiperface® encoder	see p.34
X6	Resolver connection	Resolver	see p.33
X5	Connection motor temperature monitoring	PTC, following DIN 44082 Linear temperature sensor KTY84-130 Automatic cutout Klixon	see p.35
X13	Connection ofmotor brake	Power out with cable break/overload sensor. Attention: Pay attention to freewheeling suppressor circuit	see p.30
X12	Power connection	Connection for motor. DC link (do not connect anything!)	see p.35
HW	Hardware rating plate	contains serial number and electrical performance data	see p.5
SW	Software rating plate	contains serial number, software version, MAC address	see p.5

Table 3.1 Key to connection diagram, BG1 to BG4

3.3 Overview of connections, BG5 and BG6a

The following shows the layout with the corresponding positions of plugs and terminals. To aid orientation, the connectors and terminals are labelled by abbreviations.

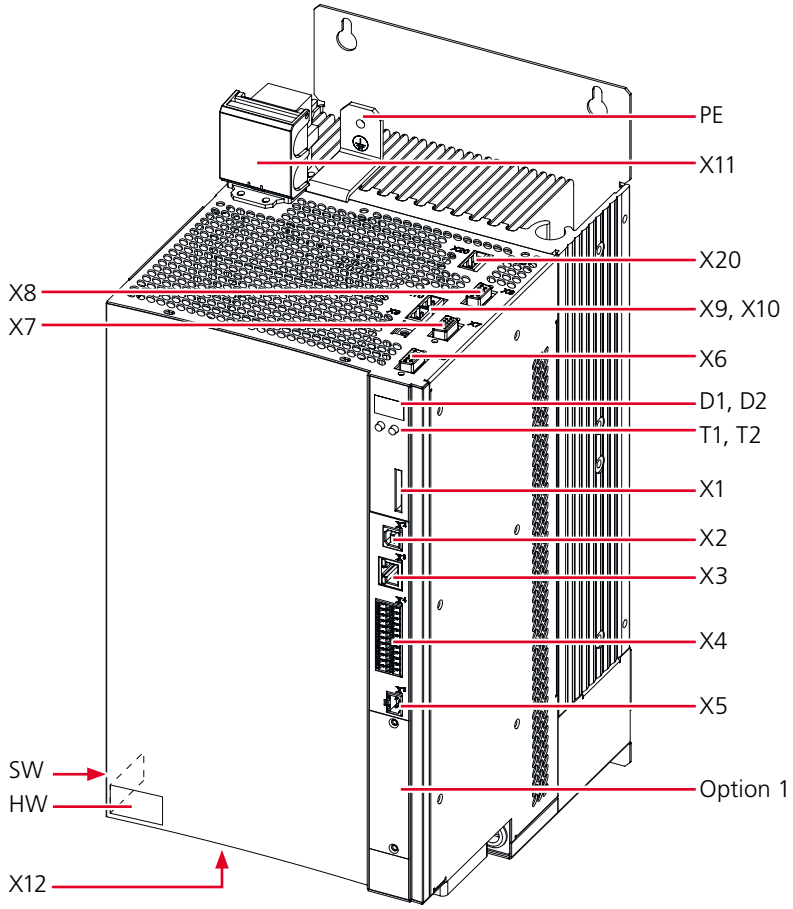


Figure 3.3 Layout, BG5 (without shields)

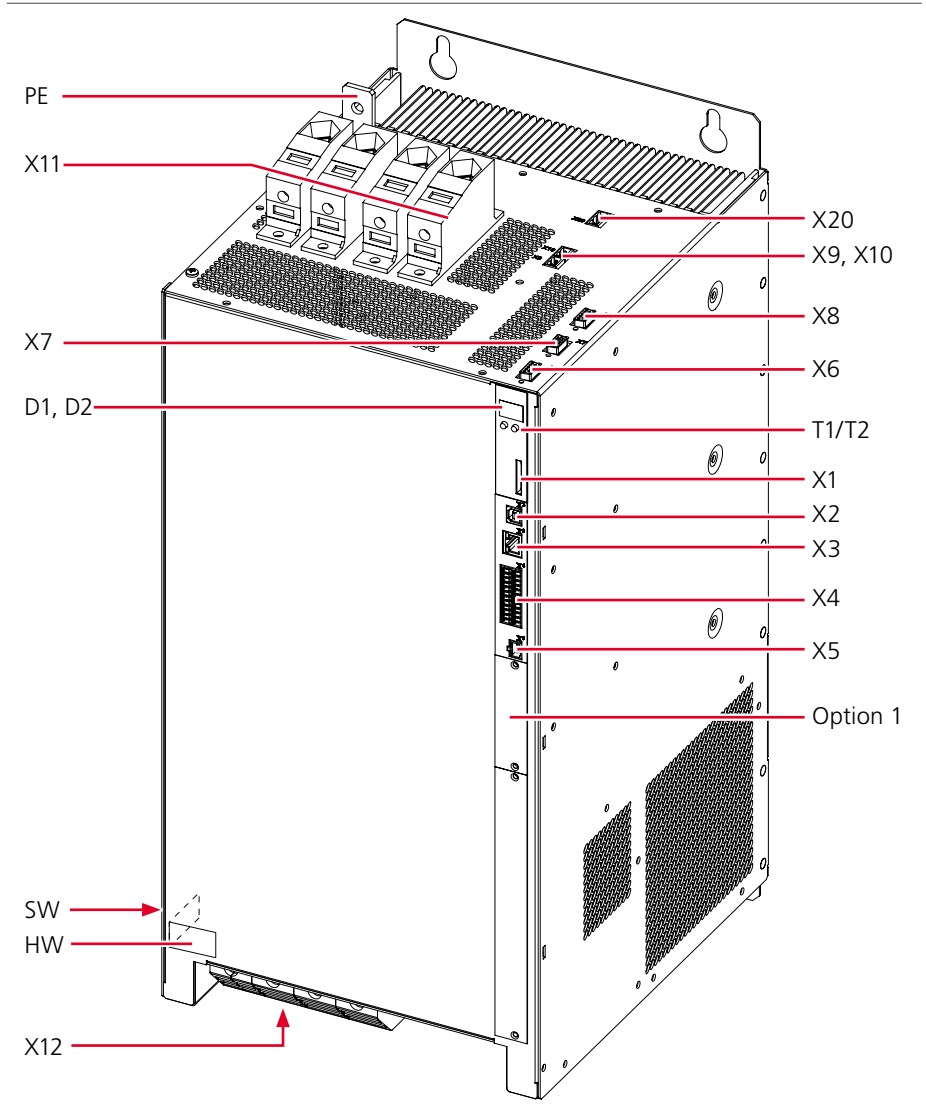


Figure 3.4 Layout, BG6a (without shields)

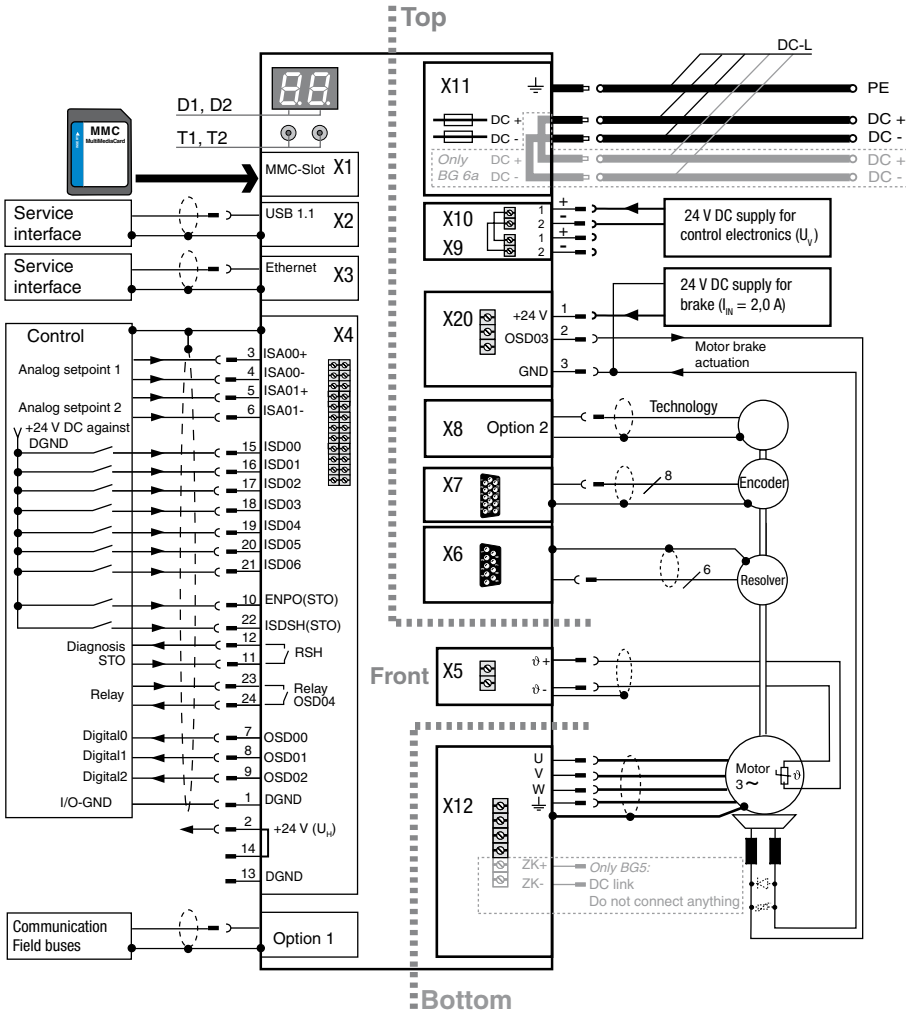


Figure 3.5 Connection diagram, BG5 and BG6a

Abbr.	Designation	Function	Page
D1, D2	7-segment display	Device status display	see p.42
T1, T2	Pushbuttons	Service functions	see p.42
X1	Slot for MMC removable storage device	Enables firmware download without PC for example	see p.41
X2	USB 1.1 port	Service interface, Plug & Play connection to PC	see p.31
X3	Ethernet port	Service interface, fast TCP/IP port (RJ45)	see p.31
X4	Control terminals	Relay output diagnosis STO, 8 digital inputs, 2 anlog inputs, 3 digital outputs, 1 additional relay output	see p.29
Option 1	Communication	Factory installed module for field busses, e.g. SERCOS, PROFIBUS-DP, EtherCAT or CANopen	see p.31
X11	DC connection	Power supply (internally protected)	see p.27
DC-L	DC link cable	Ready made-up cables for DC power supply and protective conductor	see p.83
PE	Protective conductor connection	Connection diagram see section 3.4	see p.24
X9, X10	Connection of control supply U_V	24 V DC supply voltage for control electronics of drive controller	see p.24
X8 Option 2	Technology	Factory installed module e.g for TTL encoder simulation, second Sin/Cos encoder or EnDat 2.1	see p.31
X7	High-resolution encoder interface	Sin/Cos encoder, EnDat 2.1 encoder, Hiperface® encoder	see p.34
X6	Resolver connection	Resolver	see p.33
X5	Connection motor temperature monitoring	PTC, following DIN 44082 Linear temperature sensor KTY84-130 Automatic cutout Klixon	see p.35
X20	Connection of motor brake	Power out with cable break/overload sensor. Attention: Pay attention to freewheeling suppressor circuit!	see p.30
X12	Power connection	Motor connection	see p.30
HW	Hardware rating plate	contains serial number and electrical performance data	see p.5
SW	Software rating plate	contains serial number, software version, MAC address	see p.5

Table 3.2 Key to connection diagram, BG5 and BG6a

ID no.: 1101.20B.2-00 Date: 01/2011

3.4 Protective conductor connection

Step	Action	PE mains connection to DIN EN 61800-5-1
1.	Ground every drive controller! **When operating with power supply unit:** • Interconnect the PE terminals of the DC axis controllers (up to and including BG5) and the supply unit by the ready made-up cables. • Connect the PE terminal of the supply unit and DC axis controller BG6a directly to the PE rail (main ground) in the switch cabinet. **When operating with servocontroller as supply:** • Interconnect the PE terminals of the DC axis controllers by the ready made-up cables. • Do NOT connect the PE terminal of the DC axis controller to a PE terminal of the supplying single-axis controller, but directly to the PE rail (main ground) in the switch cabinet. • Connect the supplying single-axis controller likewise directly to the PE rail (main ground) in the switch cabinet.	Rules for the PE terminal (as leakage current >3.5 mA): Use protective conductors with the same cross-section as the mains power cables, though at least 10 mm² copper. Also comply with local and national regulations and conditions.
2.	Connect the protective conductor terminals of all other components, such as line reactors* etc., in a **star configuration** to the PE rail (main ground) in the switch cabinet.	*) Components are only required for the ServoOne supply unit.

You will find a wiring diagram, also showing the protective conductor terminals, on page 28.

3.5 Electrical isolation method

The control electronics, with its logic (µP), the encoder terminals and the inputs and outputs, are electrically isolated from the power section (power supply/DC-link). All control terminals are designed as safety extra-low voltage/protective extra-low voltage (SELV/PELV) circuits and must only be operated with such SELV/PELV voltages, as per the relevant specification. This provides reliable protection against electric shock on the control side.

You therefore need a separate control supply, compliant with the requirements of a SELV/PELV.

The opposite overview shows the potential supplies for the individual terminals in detail.

This concept also delivers higher operational safety and reliability of the drive controller.

ATTENTION! A special case with regard to insulation and isolation is terminal X5 (motor PTC). In this regard refer to the notes in section 3.13 "Motor connection", starting on page 35.

SELV = Safety Extra Low Voltage

PELV = Protective Extra Low Voltage

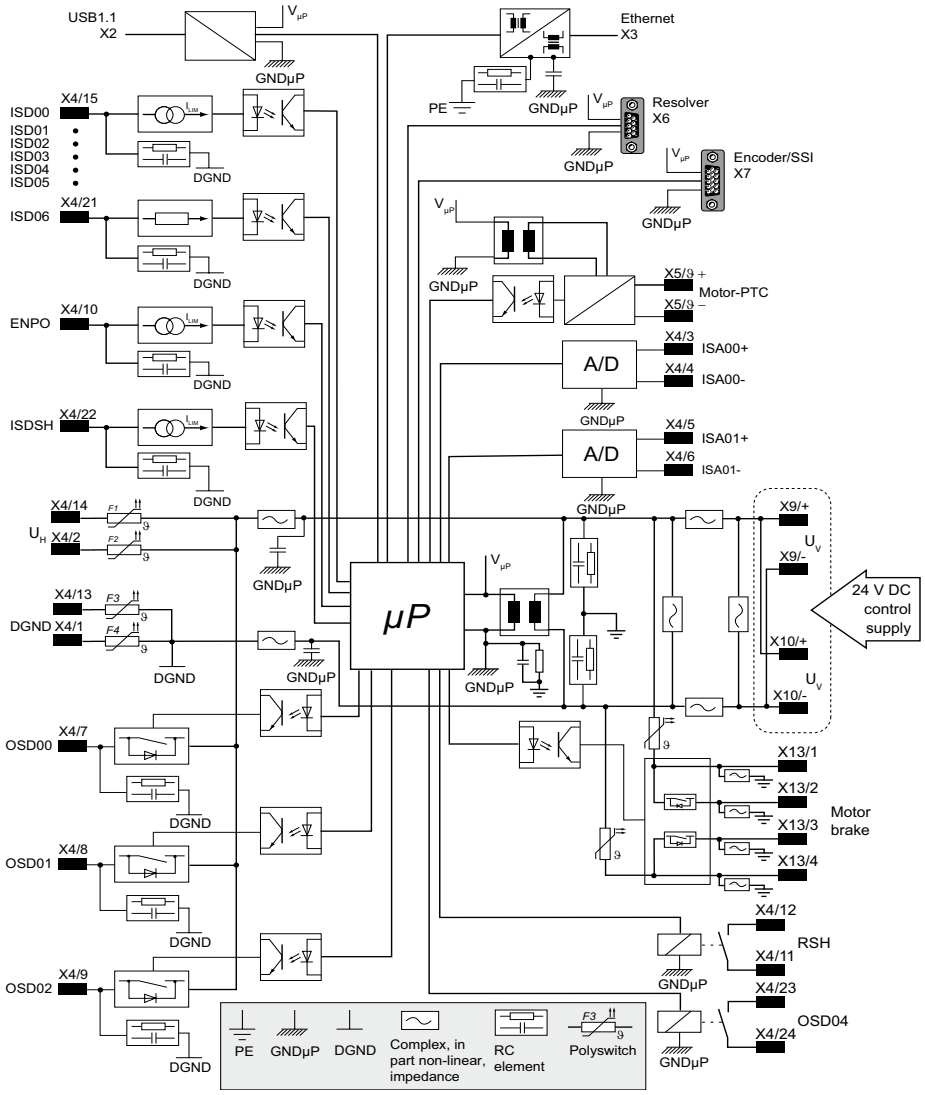


Figure 3.6 Electrical isolation method, BG1 to BG4

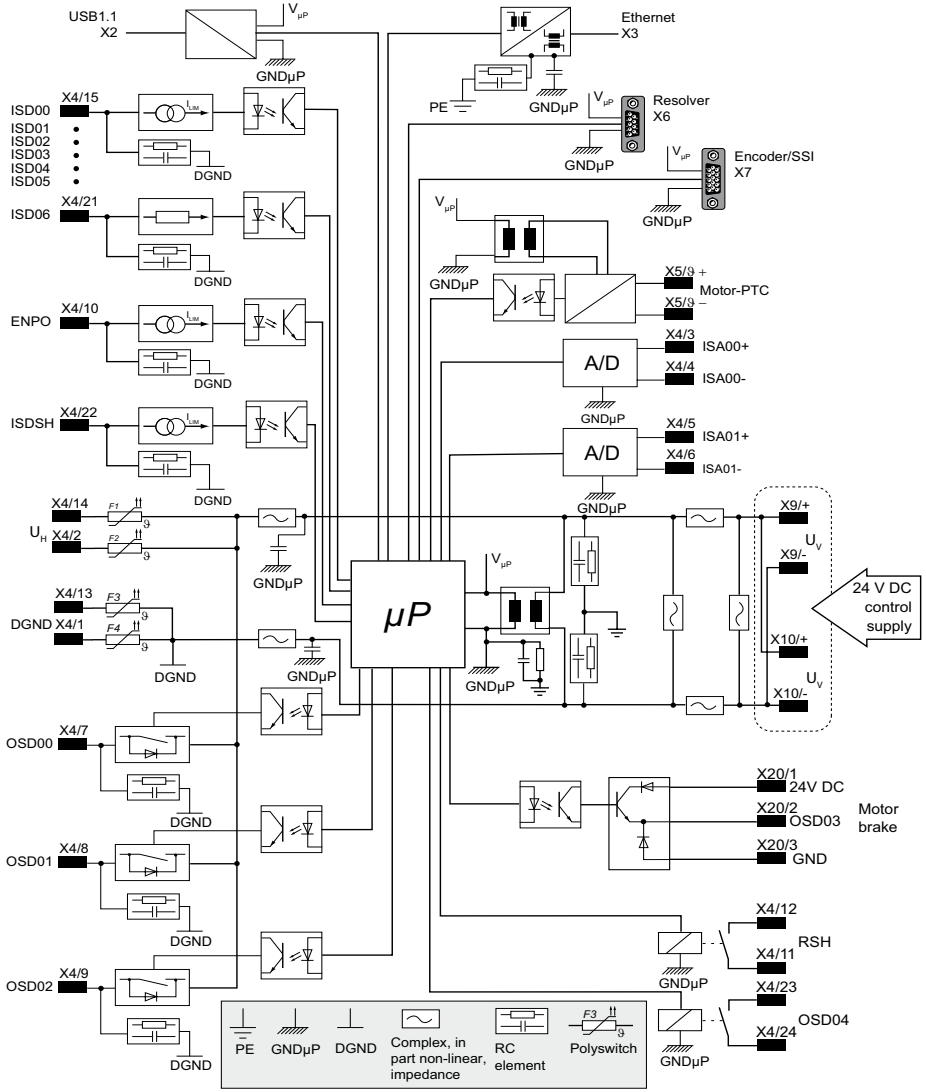


Figure 3.7 Electrical isolation method, BG5 and BG6a

3.6 Connection of supply voltages

The power supply for the ServoOne is separated into the supplies for control and power sections. The control supply must always be connected supply for the control must always be connected **first**, so that actuation of the ServoOne can first be checked or the device can be parameterized for the intended application.

3.6.1 Connection of control supply (24 V DC)

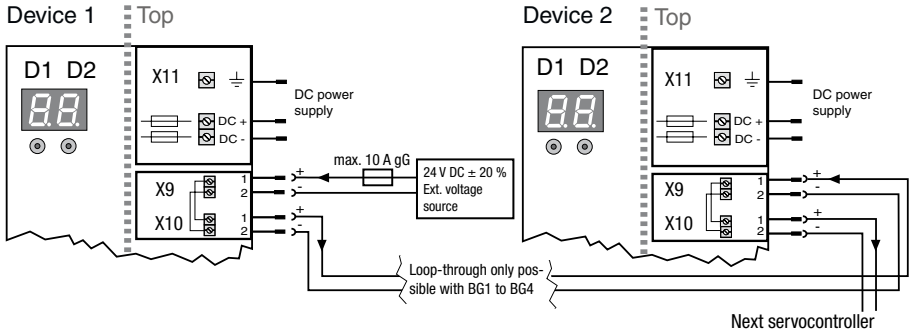


Figure 3.8 Connection of control supply

Terminal/Pin	Specification
X9/1 = + X9/2 = -	• U_V = 24 V DC ±20 % (BG5 and BG6a +20/-10 %), stabilized and filtered • For max. startup and continuous currents see table B.15 on page 84 • Continuous current capacity of terminal max. 10 A (BG5 and BG6a max. 8 A), internal polarity reversal protection • The power supply unit used must have a safe and reliable isolation against the mains system according to EN 50178 or EN 61800-5-1. • Internally wired with X10
X10/1 = + X10/2 = -	• Continuous current capacity of terminal max. 10 A (BG5 and BG6a max. 8 A) • Internally wired with X9

Table 3.3 Specification of control supply

ATTENTION! The control supply (24 V DC) should be dimensioned according to the maximum current demand. Suitable measures must also be applied to provide adequate cable protection.

NOTE: In the case of sizes BG1 to BG4, in addition to the control section the external voltage source also supplies the output for the motor holding brake. When this output is active, the current for the control section plus the current for the motor holding brake plus additional required current for digital inputs and outputs flows through terminal X9. Note this when dimensioning the voltage source for the control section and when looping-through to other devices. For the current demand of the individual device refer to appendix B, page 82 in table B.15.

3.6.2 DC power supply connection

Step	Action	Comment
1.	Make sure all ServoOne DC axis controllers are arranged in a row and abutting each other.	See mounting instructions in section 2."Mechanical installation"
2.	For the DC power supply to the axis controllers use the supplied ready made-up cables. Interconnect all (+) connections and all (-) connections via terminals X11.	The supplied ready made-up cables are as long as the corresponding device is wide.
3.	For more details on the mains power connection of the supply unit refer to the ServoOne supply unit operation manual.	

ATTENTION!

- **Connecting cable**
  Use the supplied ready made-up cables for the electrical connections between the devices. If extending the DC link is unavoidable, be sure to comply with the rules set out in section A.5 (page 83). If cables not conforming to the stipulated rules are used, LTi DRiVES can provide no guarantee of stable and safe operation.
- **Terminal cover**
  The cover over terminal X11 (DC connection) on sizes BG1 to BG5 must be closed after installing the ready made-up cables. Operation without the cover is not permitted.

NOTE:Prior to commissioning, the value of the connected supply voltage must be set in the drive controller. For more details see section 4."Commissioning".

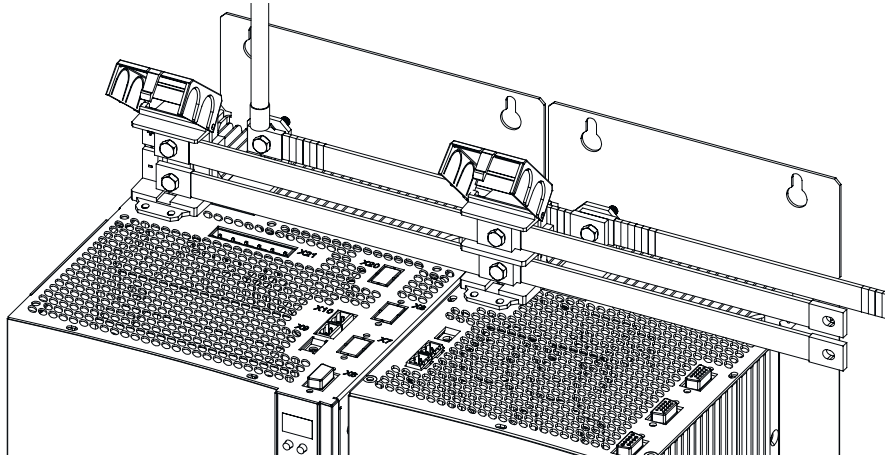


Figure 3.9 Detail: DC power supply connection, BG5

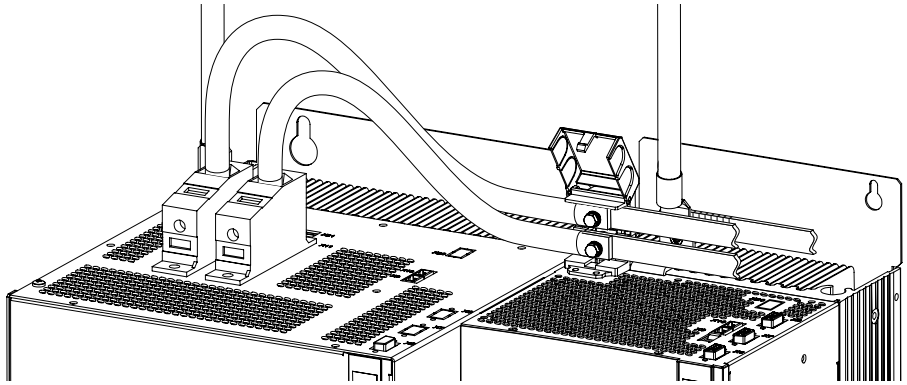
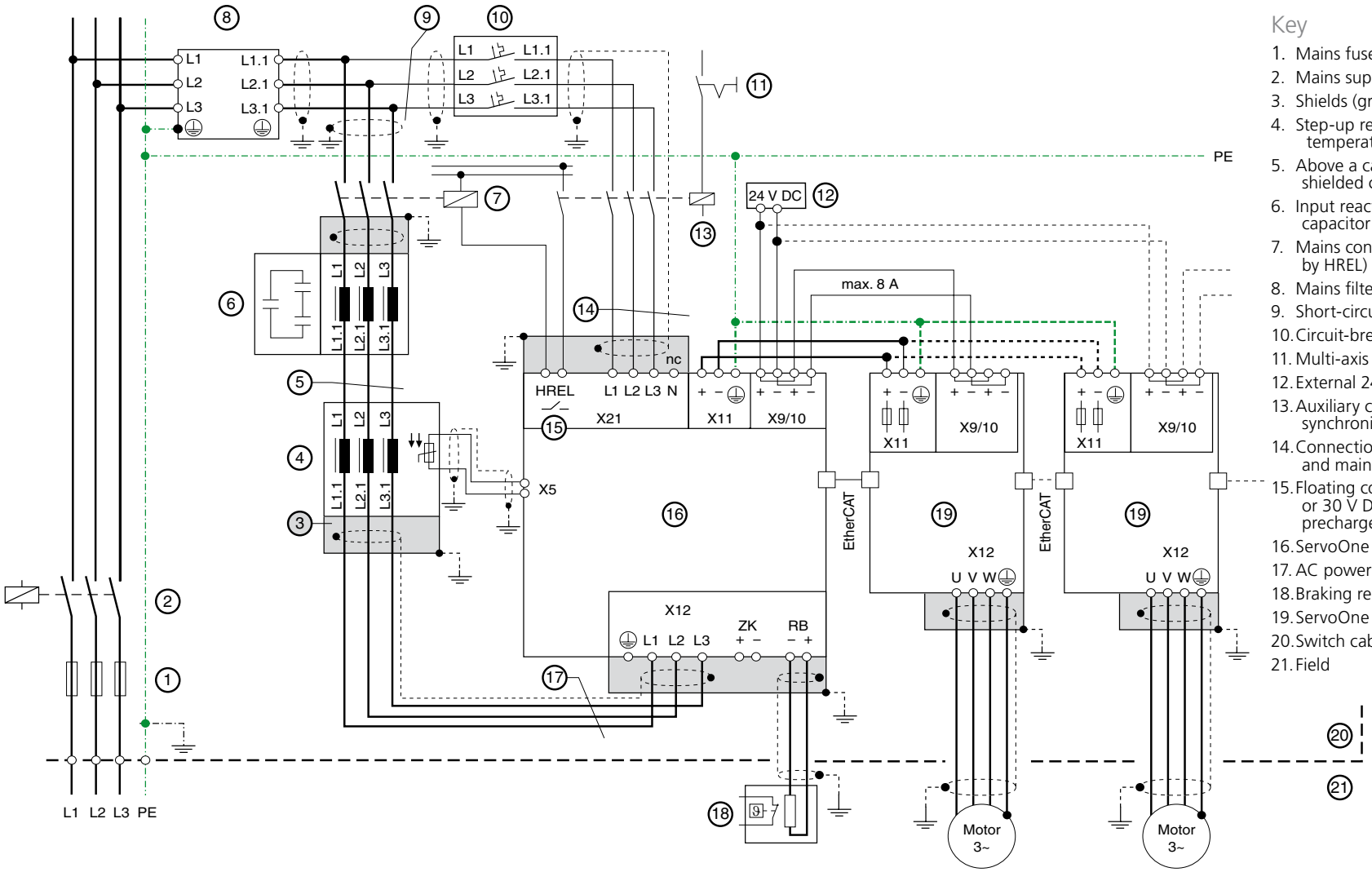


Figure 3.10 Detail: BG6a DC power supply connection to smaller DC axis controllers



Key

1. Mains fuses
2. Mains supply/emergency stop
3. Shields (grey)
4. Step-up reactor with KTY temperature sensor
5. Above a cable length of >500 mm shielded cables should be used
6. Input reactor with membrane capacitor
7. Mains contactor (after precharge by HREL)
8. Mains filters
9. Short-circuit-proof cables
10. Circuit-breaker
11. Multi-axis system On/Off
12. External 24 V DC control supply
13. Auxiliary contactor (precharge/ synchronization)
14. Connection of DC link precharge and mains synchronization
15. Floating contact: 250 V AC/5 A or 30 V DC/6 A (active when precharge complete)
16. ServoOne supply unit BG6a
17. AC power connection
18. Braking resistor
19. ServoOne DC axis controller
20. Switch cabinet
21. Field

Figure 3.11 Connection for power and control supply and protective conductor in multi-axis system (example)

3.7 Control connections

Step	Action	Comment
1.	Check whether a complete device setup is already available, i.e. whether the drive has already been configured. If this is the case, a special control terminal assignment applies. Please contact your project engineer to obtain the terminal assignment!	
2.	Choose a terminal assignment.	Initial commissioning
3.	Wire the control terminals with shielded cables. The following is strictly required: STO request X4/22, ENPO X4/10 and a start signal (with control via terminal).	Ground the cable shields over a wide area on both sides. Conductor sizes: 0.2 to 1.5 mm², with ferrules with plastic sheath max. 0.75 mm²
4.	Keep all contacts open (inputs inactive).	
5.	Check all connections again!	

3.7.1 Specification of control connections

Des.	Term.	Specification	Isolation
Analog inputs			
ISA0+ ISA0- ISA1+ ISA1-	X4/3 X4/4 X4/5 X4/6	• U_{IN} = ±10 V DC • Resolution 12 bit; R_{IN} approx. 101 kΩ • Terminal scan cycle in "IP mode" 125 µs, otherwise 1 ms • Tolerance: U ±1 % of the measuring range end value.	No
Digital inputs			
ISD00 ISD01 ISD02 ISD03 ISD04	X4/15 X4/16 X4/17 X4/18 X4/19	Default input • Frequency range < 500 Hz • Scan cycle: 1 ms • Switching level Low/High: ≤ 4.8 V / ≥ 18 V • I_{max} at 24 V = 3 mA typ.	Yes
ISD05 ISD06	X4/20 X4/21	Touchprobe or default input • Touchprobe input for fast storage of process data (e.g. actual position) – Internal signal delay ISD05 ↑: Min. 3 µs, Max. 16 µs, Typ. 8 µs ISD05 ↓: Min. 4 µs, Max. 27 µs, Typ. 15 µs ISD06 ↑↓: Typ. < 2 µs – Activation via ISD05/ISD06 = 15 (PROBE) • Default input – Frequency range ≤ 500 kHz – Scan cycle: 1 ms • Switching level Low/High: ≤ 4.8 V / ≥ 18 V • ISD05: I_{max} at 24 V = 3 mA • ISD06: I_{max} at 24 V = 10 mA typ., R_{IN} = 3 kΩ typ.	Yes
ENPO (STO)	X4/10	• Request input STO • Disable restart inhibit (STO) and enable power stage = High level • Frequency range < 500 Hz • Reaction time approx. 10ms • Switching level Low/High: ≤ 4.8 V / ≥ 18 V • At 24 V typ. 3 mA	Yes

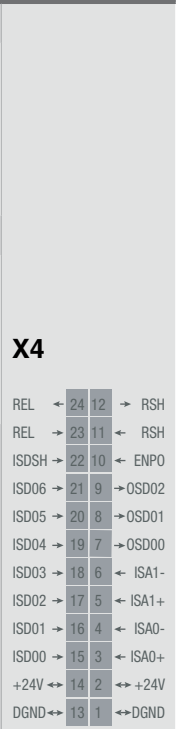


Table 3.4 Specification of control connections X4

Des.	Term.	Specification		Isolation
Digital outputs				
OSD00 OSD01 OSD02	X4/7 X4/8 X4/9	• No destruction in case of short-circuit (+24 V -> GND), but device may briefly shut down • I_{max} = 50 mA, PLC-compatible • Terminal scan cycle = 1 ms • High-side driver		Yes
STO (Safe Torque Off)				
ISDSH (STO)	X4/22	• Request input STO • Frequency range < 500 Hz • Switching level Low/High: <4.8 V / >18 V • At 24 V typ. 3 mA		Yes
RSH RSH	X4/11 X4/12	Diagnose STO, both tripping channels active, one NO contact with automatically resetting circuit-breaker (polyswitch) • 25 V / 200 mA AC, cos φ = 1 • 30 V / 200 mA DC, cos φ = 1	X4/12 X4/11	Yes
Relay outputs				
REL	X4/23 X4/24	Relay, 1 NO contact • 25 V / 1.0 A AC, cos φ = 1 • 30 V / 1.0 A DC, cos φ = 1 • Switching delay approx. 10 ms • Cycle time 1 ms	X4/23 X4/24	
Auxiliary voltage				
+24 V	X4/2 X4/14	• Auxiliary supply to feed the digital control inputs • $U_H = U_V$-ΔU (ΔU typically approx. 1.2 V), no destruction in case of short-circuit (+24 V -> GND), but device may briefly shut down. • I_{max} = 80 mA (per pin) with self-resetting circuit-breaker (polyswitch)		Yes
Digital ground				
DGND	X4/1 X4/13	reference ground for 24 V, I_{max} = 80 mA (per pin) with self-resetting circuit breaker (polyswitch)		Yes

X4

REL	24	12	RSH
REL	23	11	RSH
ISDSH	22	10	ENPO
ISD06	21	9	OSD02
ISD05	20	8	OSD01
ISD04	19	7	OSD00
ISD03	18	6	ISA1-
ISD02	17	5	ISA1+
ISD01	16	4	ISA0-
ISD00	15	3	ISA0+
+24V	14	2	+24V
DGND	13	1	DGND

Table 3.4 Specification of control connections X4

ATTENTION! With high currents flowing through the ground terminals a high resistance isolation from the device ground is required. This may cause incorrect response of the drive (avoid ring currents in the wiring).

NOTE: Note that in the event of a fault the supply unit may no longer be able to feed regenerative power from the axis controllers back into the grid. In order to prevent destruction of the supply unit braking resistor in sustained regenerative mode, the axis controller and supply unit can be mutually locked via X4. For more information and an example of circuit configuration refer to the appendix, page 87.

3.7.2 Brake driver

Connector X13 (BG1 to BG4) is intended for connection of a motor brake.

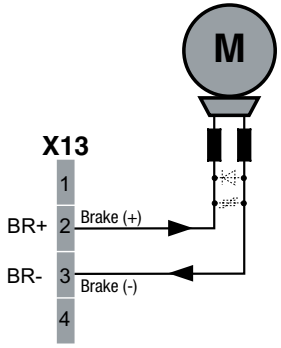
Des.	Term.	Specification	Connection
+24 V BR+ BR- GND	X13/1 X13/2 X13/3 X13/4	• Short-circuit proof • Voltage supply is via the control supply U_V on X9 or X10 • $U_{BR} = U_V$-ΔU` (ΔU` typically approx. 1.4 V) • To actuate a motor holding brake up to I_{BR} = 2.0 A max., for brakes with higher current requirements a relay must be interposed. • Overcurrent causes shutdown • Also usable as configurable digital output. • Interruptible cable break monitoring < 500 mA in condition "1" (up to relay)	

Table 3.5 Specification of terminal connections X13

Connector X20 (BG5 and BG6a) is intended for connection of a motor brake.

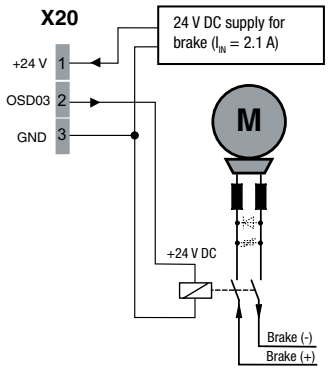
Des.	Term.	Brake driver X20	Connection
+24 V OSD03 GND	X20/1 X20/2 X20/3	• Short-circuit proof • External voltage supply 24 V DC (I_{IN} = 2.1 A) required • To actuate a motor holding brake of up to I_{BR} = 2.0 A max., for brakes with higher current requirements a relay must be interposed. • Overcurrent causes shutdown • Interruptible cable break monitoring < 200 mA typically in condition "1" (up to relay)	

Table 3.6 Specification of terminal connections X20

3.8 Specification of USB port

The service and diagnostic interface X2 is executed as a USB V1.1 port. It is suitable only for connection of a PC for commissioning, service and diagnosis purposes using the DriveManager 5 software.

Technical specification:

- USB 1.1 standard - full speed device port
- Connection via standard commercially available USB interface cable type A to type B (see also ServoOne system catalogue)

3.9 Specification of Ethernet port

The service and diagnostic interface X3 is executed as an Ethernet port. It is suitable only for connection of a PC for commissioning, service and diagnosis purposes using the DriveManager 5 software.

Technical specification:

- Transfer rate 10/100 MBits/s BASE-T
- Transfer profile conforming to IEEE802.3
- Connection via standard commercially available crosslink cable (see also ServoOne system catalogue)

3.10 Option 1

Depending on the ServoOne variant, option 1 is factory-configured with various options. Field bus options such as EtherCAT or SERCOS are available.

You will find all available options in the ServoOne system catalogue. The user manuals for the respective options provide detailed information on commissioning.

3.11 Option 2

Option 2 can be fault-configured with various technology options. Additional or special encoders can be evaluated with it for example.

You will find all available options in the ServoOne system catalogue. The user manuals for the respective options provide detailed information on commissioning.

3.12 Encoder connection

All encoder connections are located on the top of the unit.

3.12.1 Encoder connection of LSH/T motors

Please use the ready made-up motor and encoder cables from LTi DRiVES to connect the LSH/T synchronous motors.

3.12.2 Matching motor/encoder cable to drive controller

Compare the rating plates of the components. Make absolutely sure to use the correct components according to variant A, B or C!

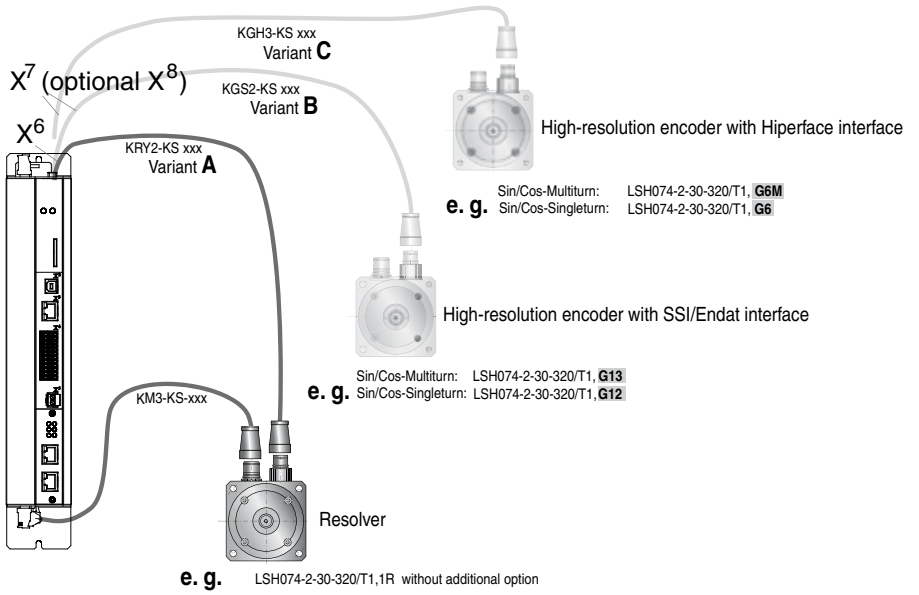


Figure 3.12 Matching motor/encoder cable

	Motor (with installed encoder)	Encoder cable	Connection of the drive controller
Variant A	with resolver e.g. LSH/LST H074-2-30-320/T1, 1R without further options	KRY2-KSxxx	X6
Variant B	G13: = Sin/Cos multi-turn encoder with SSI/EnDat interface e.g. LSH/LST H074-2-30-320/T1,G13	KGS2-KSxxx	X7
	G12: = Sin/Cos single-turn encoder with SSI/EnDat interface e.g. LSH/LST H074-2-30-320T1,G12	KGS2-KSxxx	X7
Variant C	G6: = Sin/Cos single-turn encoder with Hiperface® interface e.g. LSH/LST H074-2-30-320/T1,G6	KGH3-KSxxx	X7
	G6M: = Sin/Cos multi-turn encoder with Hiperface® interface e.g. LSH/LST H074-2-30-320/T1,G6M	KGH3-KSxxx	X7

Table 3.7 Variants of motors, encoder type and encoder cable

NOTE: Do not split the encoder cable, for example to route the signals via terminals in the switch cabinet. The knurled screws on the D-Sub connector housing must be tightly locked!

3.12.3 Ready made-up encoder cables

The specifications can only be assured when using the LTi system cables.

Encoder cable KRY2-KS-xxx

K	RY2	-	KS	xxx
Ready made-up cable				
	Resolver cable RY2 *Encoder cable SSI, EnDat* GS2 *Encoder cable Hiperface®* GH3			
			Festoon-compatible KS	
				Cable length (m)

Order code

Technical data

	KRY2-KSxxx	KGS2-KSxxx	KGH3-KSxxx
Motors with encoder system	Resolver	G3, G5, G12.x (single/multi-turn encoder with SSI/ Endat interface)	G6, G6.x (single/multi-turn encoder with Hiper-face® interface)
Controller-end assignment (sub-D connector)	1 = S2 2 = S4 3 = S1 4 = n.c. 5 = PTC+ 6 = R1 7 = R2 8 = S3 9 = PTC-	1 = A- 2 = A+ 3 = VCC (+5 V) 4 = DATA+ 5 = DATA- 6 = B- 8 = GND 11 = B+ 12 = VCC (Sense) 13 = GND (Sense) 14 = CLK+ 15 = CLK- 7, 9, 10 = n.c.	1 = REFCOS 2 = +COS 3 = U_s 7 - 12 V 4 = Data+ RS485 5 = Data- RS485 6 = REFSIN 7 = Jumper to pin 12 8 = GND 11 = +SIN 12 = Jumper to pin 7 9, 10, 13, 14, 15 = n.c.
Festoon-compatible	Yes		

Table 3.8 Technical data – encoder cable

	KRY2-KSxxx	KGS2-KSxxx	KGH3-KSxxx
Minimum bend radius	90 mm	100 mm	90 mm
Temperature range	-40 ... +85 °C	-35 ... +80 °C	-40 ... +85 °C
Cable diameter approx.	8.8 mm		
Material of outer sheath	PUR		
Resistance	Resistant to oil, hydrolysis and microbic attack (VDE0472)		
Approvals	UL-Style 20233, 80 °C - 300 V, CSA-C22.2N.210-M90, 75 °C - 300 V FT1		

Table 3.8 Technical data – encoder cable

3.12.4 Resolver connection

A resolver is connected to slot X6 (9-pin D-Sub female).

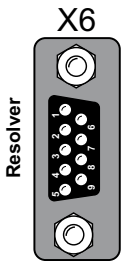
Fig.	X6/Pin	Function
	1	Sin+ / (S2) analog differential input track A
	2	Refsin / (S4) analog differential input track A
	3	Cos+ / (S1) analog differential input track B
	4	Supply voltage 5..12 V, internally connected to X7/3
	5	Do not connect anything!
	6	Ref+ analog excitation
	7	Ref- analog excitation (ground reference point to pin 6)
	8	Refcos / (S3) analog differential input track B
	9	Do not connect anything!

Table 3.9 Pin assignment X6

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3.12.5 Connection for high-resolution encoders

Interface X7 enables evaluation of the following encoder types.

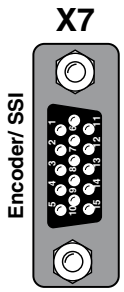
Fig.	Function
	**Sin/Cos- encoder with zero pulse:** • e.g. Heidenhain ERN1381, ROD486 • U_V = 5 V ± 5 %, I_{max} = 150 mA
	Heidenhain Sin/Cos encoder with EnDat2.1 interface: • e.g. 13-bit single-turn encoder (ECN1313.EnDat01) and 25-bit multi-turn encoder (EQN1325-EnDat01) • U_V = 5 V ± 5 %, I_{max} = 150 mA
	Sin/Cos encoder with SSI interface: • e.g. 13-bit single-turn and 25-bit multi-turn encoders (ECN413-SSI, EQN425-SSI) • U_V = 5 V ± 5 %, I_{max} = 150 mA
	Sick-Stegmann Sin/Cos encoder with HIPERFACE ® interface: • Single-turn and multi-turn encoders, e.g. SRS50, SRM50 • U_V = 7 to 12 V (typ. 11 V) ± 5 %, I_{max} = 100 mA

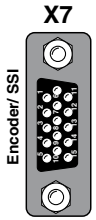
Table 3.10 Suitable encoder types on X7

NOTE: Encoders with a power supply of 5 V ± 5 % must have a separate sensor cable connection. The encoder cable detects the actual supply voltage at the encoder, thereby compensating for the voltage drop on the cable. Only use of the sensor cable ensures that the encoder is supplied with the correct voltage. The sensor cable must always be connected.

Electrical specification of interface X7:

Select the cable type specified by the motor or encoder manufacturer, bearing in mind the following:

- Connect the differential track signals A, B, R or CLK, DATA to each other via twisted wires.
- Do not separate the encoder cable, for example to route the signals via terminals in the switch cabinet.

Fig.	X7/Pin	Function Sin/Cos	Absolute encoder SSI/EnDat 2.1	Absolute encoder HIPERFACE®
	1	A-	A-	REFCOS
	2	A+	A+	+COS
	3	+5 V ±5 %, max. 150 mA, monitoring via sensor cable		7 to 12 V / (typ. 11 V) max. 100 mA
	4	-	Data +	
	5	-	Data -	
	6	B -	B -	REFSIN
	7	-	-	U_S - Switch
	8	GND	GND	GND
	9	R-	-	
	10	R+	-	
	11	B+	B+	+SIN
	12	Sense+		U_S - Switch
	13	Sense-		-
	14	-	CLK+	-
	15	-	CLK-	-

After connecting pin 7 to pin 12 a voltage of 11 V is applied at X7, pin 3!

Table 3.11 Pin assignment of connector X7

NOTE: The encoder supply on X7 is short-circuit proof in 5 V and 11V operation.

3.13 Motor connection

Step	Action	Comment
1.	Specify the cable cross-section dependent on the maximum current and ambient temperature.	Cable cross-section according to local and country-specific regulations and conditions.
2.	Connect the shielded motor cable to terminals X12/ U, V, W and ground the motor to ⏚.	Mount shield at both ends to reduce interference emission. Secure shield connection plate of motor terminal X12 by **both** screws.
3.	Wire the temperature sensor (if present) to X5 using separately shielded cables and activate the temperature evaluation via DriveManager 5.	Mount shield at both ends to reduce interference emission.

ATTENTION! For terminal X5 it must be ensured that the temperature monitor used is equipped with a basic isolation in accordance with 61800-5-1 against the motor winding.

NOTE: In the event of a short-circuit or ground fault in the motor cable, the power stage is disabled and an error message is generated.

3.13.1 Connection of LSH/LST motors

ATTENTION! Use only motors permitting connection of the motor temperature monitor solely to X5 of the DC axis controller. This must be expressly specified when ordering the motor.

NOTE: Please use a ready made-up motor cable from LTi DRiVES to connect the servomotor series LSH xxx and LST xxx.

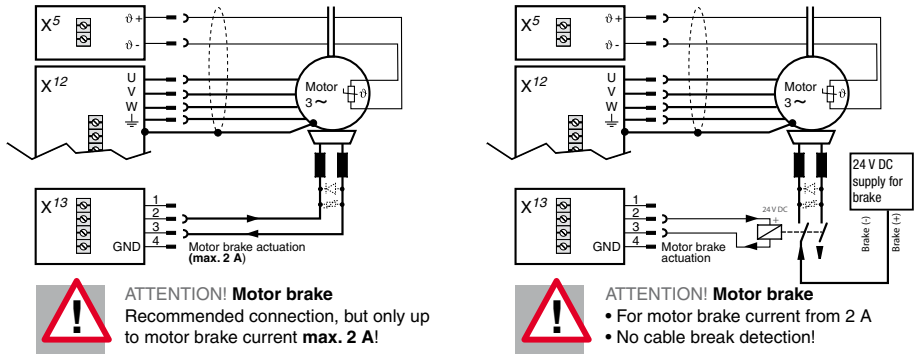


Figure 3.13 Connection options of motors BG1 to BG4

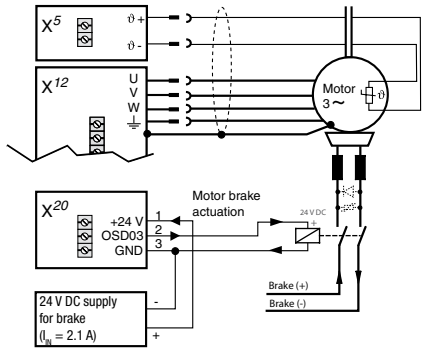
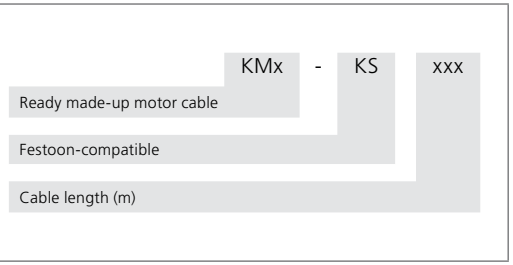


Figure 3.14 Connection of motors BG5 and BG6a

3.13.2 Ready made-up motor cable

Motor cable KM3-KSxxx



Order code

Technical data – motor cable

		KM2/3-KSxxx	KM2/3-KSxxx-24A	KM2/3-KSxxx-63A
For motors with plug-in power connection		to I_N = 16 A	to I_N = 24 A	to I_N = 63 A
Minimum bend radius	in fixed installation	90 mm	115 mm	165 mm
	in flexible use	120 mm	150 mm	220 mm
Temperature range		-30 ... +80 °C		
Cable diameter approx.		12 mm	15 mm	22 mm
Cable cross-section		4G1.5 + 2 x 2 x 0.75 mm²	4G2.5 + 2 x 2 x 1 mm²	4G10 + 2 x 1.5 mm² + 2 x 1 mm²
Outer sheath material		PUR		
Resistance		Resistant to oil, hydrolysis and microbic attack (VDE0472)		
Wiring		U = 1 V = 2 W = 3 Ground = ye/gn PTC = 5 PTC = 6 Brake + = 7 Brake - = 8		
Approval		UL AWM 80 °C - 600 V/1000 V CSA AWM 80 °C - 600 V/1000 V FT1		

Table 3.12 Technical data – motor cable

3.13.3 Switching in the motor cable

ATTENTION! Switching in the motor cable must take place with the power cut and the power stage disabled, as otherwise problems such as burned-off contactor contacts may occur. In order to ensure unpowered switch-on, you must make sure that the contacts of the motor contactor are closed before the drive controller power stage is enabled. At the moment the contactor is switched off it is necessary for the contact to remain closed until the drive controller power stage is shut down and the motor current is 0. This is done by inserting appropriate safety times for switching of the motor contactor in the control sequence of your machine.

Despite these measures, the possibility cannot be ruled out that the drive controller may malfunction during switching in the motor cable.

4. Commissioning

4.1 Notes for operation

ATTENTION!

- **Safety instructions**
  Observe the safety instructions set out in section 1 during operation.
- **During operation,**
  be sure to avoid ...
  – penetration of the device by foreign bodies or damp;
  – aggressive or conductive substances in the immediate vicinity;
  – covering over vent openings.
- **Cooling**
  – The device heats up in operation and at the heat sink may reach temperatures of up to 100 °C. It poses a risk of skin burns if touched.
  – Cooling air must be able to flow through the device without restriction.

NOTE: For commissioning and operation of the DC axis controller within a ServoOne multi-axis system, be sure also to refer to the Operation Manual for the supply unit or the supplying AC servocontroller.

4.2 Initial commissioning

When the ServoOne DC axis controller has been installed as per section 2 and wired with all required voltage supplies and external components as per section 3, initial commissioning is carried out in the following steps:

Step	Action	Comment
1.	Installing and starting the PC software	see DriveManager 5 Installation Manual
2.	Switching on control voltage	see section
3.	DriveManager 5 user software Communication, installation	For installation instructions refer to theDriveManager 5 installation manual and the Online Help.
4.	Parameter setting	For more details see ServoOne parameter descriptions
5.	Drive under control (test run)	Mains voltage on, pay attention to STO function, start contact, specify setpoint

NOTE: Details relating to STO (Safe Torque Off) are are not taken into consideration for initial commissioning – see section 6.

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4.2.1 Switching on control voltage

2. For initialization and parameter setting, first switch on only the 24 V control voltage. Do **not yet** switch on the power supply.

Display readout after switching on the control supply

D1	D2	Action	Explanation
		Switch-on of ext. 24 V control voltage	Initialization in progress
		Initialization complete	Not ready for start

Table 4.1 Switch-on status of ServoOne (after connection of the 24 V DC control voltage)

NOTE: For details on the control supply refer to section 3.6 "Connection of supply voltages", starting on page 26.

4.2.2 Connecting the PC and drive controller

3. The PC can be connected to the drive controller via USB or Ethernet (TCP/IP). Connect the PC and drive controller to the corresponding cables.

NOTES:

- **Initialization**
  Communication between the PC and the drive controller can only be established once the drive controller has completed its initialization.
- **USB driver and TCP/IP configuration**
  If the PC does not detect the connected drive controller, check the driver and the settings of the relevant interface (see DriveManager 5 Installation Manual).

4.2.3 Parameter setting

4. For drive system setup DriveManager 5 includes a Commissioning Wizard. Start the Wizard.

NOTES:

- **Online Help**
  For a detailed description of DriveManager 5 and of the Commissioning Wizard, refer to the DriveManager 5 Online Help.
- **Motor data set**
  When using LTi servomotor type LSH or LST, the latest version of the necessary motor data set can be obtained from the "Downloads" section at http://drives.lt-i.com.

4.2.4 Controlling the drive with DriveManager 5

5. Switch on the power supply. Then enable the power stage and activate the control. The drive should be tested with no coupled mechanism.

DANGER FROM ROTATING PARTS! Danger to life from uncontrolled rotation! Before motors with a feather key at the shaft end are commissioned, the feather key should be secured against being ejected, if this cannot be prevented by drive elements such as pulleys, couplings, or the like.

ATTENTION!

- **Avoid damage by motor test run!**
  In this case it must be ensured that the test will not cause any damage to the system! Pay particular attention to the limitations of the travel range. Please note that you yourself are responsible for safe operation. LTi DRiVES GmbH cannot accept liability for any damage incurred.

- **Destruction of the motor**
  - The motors are intended for operation on the drive controller. Direct connection to the mains supply may destroy the motor.
  - The motor surfaces may become extremely hot. Temperature-sensitive items should therefore not be placed on top of or attached to the motors. Protective measures may be needed to prevent touching.
  - In order to avoid overheating of the motor, the temperature sensor installed in the winding must be connected to the terminal of the drive controller temperature monitor (X5).
  - The motor brake (if installed) should be checked for fault-free functioning before commissioning of the motor. The optionally installed standstill holding brake is only designed for a limited number of emergency braking operations. Use as a working brake is prohibited.

Display readout after switching on the power supply

D1	D2	Action	Reaction	Explanation
5	2	Switching on the power supply	Open-loop control ready, power stage ready, closed-loop control disabled	Device is ready to switch on

Table 4.2 Readout D1, D2 after switching on the power supply

NOTES:

- **Inputs "ISDSH" and "ENPO"**
  For step 1 from table 4.3 the two inputs "ISDSH" and "ENPO" of terminal X4 must be configured as a minimum.
- **Readiness**
  When operating with a servocontroller as the supply, all DC axis controllers in the system must be in state 2 (ready for operation) before the first axis starts up.
- **Manual mode dialog**
  The best way to execute step 2 from table 4.3 is via the "Manual mode" dialog of DriveManager 5. For details refer to the Online Help.
- **Configuration of inputs/outputs**
  If step 2 is to be executed via the inputs of terminal X4, the sources for "START CONTROL" and speed reference setpoint should be configured accordingly in the "Inputs/outputs" subject area of DriveManager 5.

Power-up sequence to start the drive

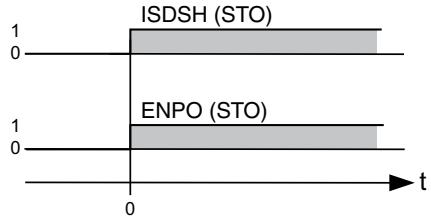
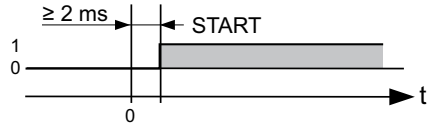
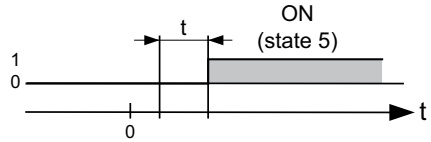
1. Disable "STO" safety function by setting inputs "ISDSH" and "ENPO" (see section 6.)	
2. Activate "START CONTROL" at the earliest 2 ms after step 1 and set the reference speed	
3. Observe your system/ plant and check the drive response.	
t = Motor-dependent delay time	

Table 4.3 Power-up sequence

Display readout after drive start-up

D1	D2	Action	Reaction	Explanation
H	3	"STO" and power stage "ENPO" enabled	Ready for start	Power stage ready
		ATTENTION! Make sure before the next step, "Start enable", to preset a plausible setpoint value by way of the analog input! The presetting is transferred directly to the drive when motor control starts.		
H	5	"Start" enabled	On	Drive powered, control active

Table 4.4 Display D1, D2 during motor activation

For details on adapting the drive in your application refer to the DriveManager 5 Online Help and the ServoOne Application Manual.

4.3 Serial commissioning

An existing parameter data set can be transferred to other ServoOne drive controllers using DriveManager 5 or a MMC card. For details refer to theDriveManager 5 Online Help or section 4.4 (following page).

NOTE: iPlc programs can only be installed on a ServoOne drive controller using the CoDeSys programming system.

4.4 Integrated operator control unit and MMC card

The built-in operator control unit permits diagnosis of the ServoOne. In addition, use of the MMC card aids serial commissioning without a PC. The operator control unit comprises the following elements, all located on the front of the device:

- 2-digit 7-segment display (D1, D2)
- Two pushbuttons (T1, T2)
- MMC slot (X1)
  MMC*plus* cards with 128 MB to 1 GB memory capacity and 3.3 V supply voltage can be inserted (e.g. LTi DRiVES type SC-MMC128 – see also ServoOne system catalogue).

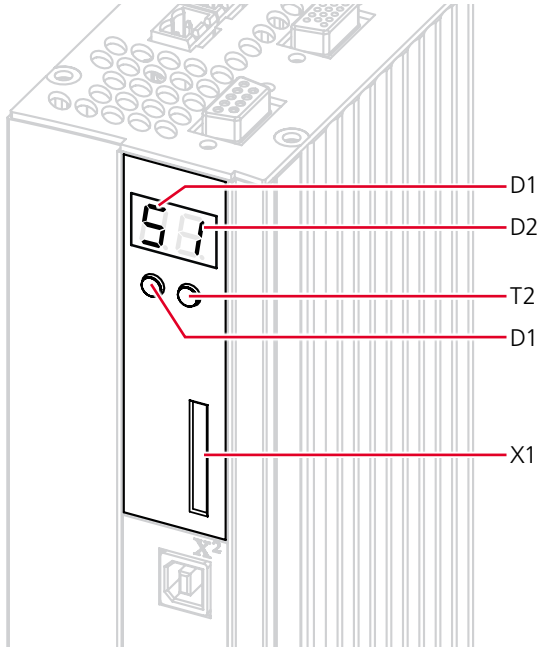


Figure 4.1 Integrated operator control unit

The following functions and displays are available:

- Display of device state (see section 5.1.1starting on page 47)
  The device state is displayed after switching on the control voltage. If no input is made via the keypad for 60 seconds, the display switches back to the device state.
- Display of device error state (see section 5.1.2 starting on page 47)
  If a device error occurs the display immediately switches to show the error code.
- Parameter setting (display "PA") (see section 4.4.3 starting on page 43)
  Reset device parameters to factory defaults and data set handling by way of the MMC card
- Ethernet IP address setting (display "IP") (see section 4.4.4 starting on page 44)
  Setting of the Ethernet IP address and the subnet mask
- Field bus settings (display "Fb") (see section 4.4.5 starting on page 45)
  Setting of field bus address for example
- Firmware update with MMC card (see section 4.4.6 starting on page 46)

4.4.1 Functions of buttons T1 and T2

By way of the keypad the different menus are activated and the relevant functions controlled.

Button	Function	Comments
T1 (left)	• Activate menu (quit device state display) • Scroll through menus/submenus • Set values - left-hand segment display (D1)	Button T1 can be held down for any length of time, as the display merely scrolls through the available menu items at the respective level. No settings are changed.
T2 (right)	• Select the highlighted menu • Set values - right-hand segment display (D2)	Button T2 must **not** be held down for any length of time, as the display would then immediately move up in the menu structure from one level to the next and alter the parameter ultimately reached. So be sure to release button T2 every time the display changes.
T1 and T2 simultaneously	• Menu level up • Apply selection • Acknowledgement	After simultaneously pressing T1 and T2 the applied value flashes for five seconds. During this time the save operation can be aborted by pressing any button without the setting being applied. Otherwise the new value is saved after five seconds.
General		• The button press time until an action is executed is around 1 second. • If no user action occurs for 60 seconds, the display switches back to the device status.

Table 4.5 Functions of buttons T1 and T2

4.4.2 Display

The following table defines various readouts and items of status information shown on the display.

Display	Meaning
	Menu entries ("PA" is given as an example here; for other possible entries see sections 4.4.4 and 4.4.5)
	[flashing decimal points] Selected function in action (e.g write to/read from MMC card)
	[two lines] Entry/function not available
	[OK] Action completed successfully, no errors
	[Error] • Action via operator control unit **not** completed successfully, "Er" flashes alternately with error number (see section 4.4.3) • Device error display, "Er" flashes alternately with error number and error location (see "ServoOne Application Manual")
	Numerical values ("10" is by way of example in this case) • On the Parameters menu (PA) data set and error numbers are displayed in **decimal** format. • All other values are displayed in **hexadecimal** format. In those cases the displayed "10" would represent the decimal value 16.

Table 4.6 Meaning of display

NOTE: If no input is made via the keypad for 60 seconds, the display switches back to the device state.

4.4.3 Parameters menu (PA)

On the Parameters menu the following functions are available:

- Reset device settings to factory defaults
- Data set handling with MMC card

NOTES:

- It is only possible to operate the MMC if the power stage is **not** active.
- Accessing the MMC may as long as 2 minutes. During thistime both decimal points flash.

Menu level 1	Menu level 2	Parameter	Value range	Meaning	Explanation
PA	Pd	-	00..99	Parameter download *)	100 data sets (0..99) can be read from the *path: \PARA\TRANSFER\PDSxx.dmd* (xx = 00.99) by the MMC.
	Pu	-	00..99	Parameter upload *)	100 data sets (0..99) can be stored on the MMC in the directory *\PARA\TRANSFER\PDSxx.dmd* . The directory is generated automatically. Existing data sets may be overwritten.
	Pr	-	-	Parameter reset	Reset device settings to factory defaults.
	Pc	-	-	Parameter clear	Clear all data sets on the MMC card.

) It is only possible to operate the MMC if the power stage is **not active. Accessing the MMC may as long as 2 minutes.*

Table 4.7 Parameters menu

Error numbers

A failed user action is indicated by an error message. The message consists of an alternating display of "Er" and the error number.

NOTE: The error messages displayed during user input should not be confused with drive error messages. For detailed information on the error codes and on error management refer to the "ServoOne Application Manual".

Error number	Meaning
00	File System No Error
01	File System Any file system error
02	File System command rejected
03	File System function parameter invalid
04	File System create file error
05	File System open file error
06	MMC create directory failed
07	MMC mounting error
08	MMC unmounting error
09	MMC using not allowed with current technology option card
10	MMC error uninstall X12 card
11	MMC not inserted
12	MMC mounting, create node
13	MMC not supported by hardware (not NSP 257)
14	MMC device in control enabled
15	MMC load parameter data set to device failed
16	MMC save parameter data set failed
17	Parameter reset to factory settings failed
18	Parameter write access failed
19	Save parameter data set non volatile failed
20	Not all parameters written
21	Error while reset to factory settings

Table 4.8 Error numbers

4.4.4 Ethernet IP address menu (IP)

An Ethernet TCP/IP port is available as a service and diagnostics interface. The IP address is factory set to 192.168.39.5. It can be changed using the DriveManager 5 PC software or by way of the display.

Menu level 1	Menu level 2	Parameter	Value range	Meaning	Explanation
IP	Iu	b0	00..FF	IP address update byte 0	Setting of byte 0 of the IP address in hexadecimal format (e.g. "05" for 192.168.39.**5**)
		b1	00..FF	IP address update byte 1	Setting of byte 1 of the IP address in hexadecimal format (e.g. "27" for 192.168.39.5)
		b2	00..FF	IP address update byte 2	Setting of byte 2 of the IP address in hexadecimal format (e.g. "A8" for 192.168.39.5)
		b3	00..FF	IP address update byte 3	Setting of byte 3 of the IP address in hexadecimal format (e.g. "C0" for 192.168.39.5)
	Ir	-	-	IP reset to factory setting	Reset IP address to factory default (192.168.39.5)
	Su	b0	00..FF	Subnet mask update byte 0	Setting of byte 0 of the subnet mask in hexadecimal format (e.g. "00" for 255.255.255.0)
		b1	00..FF	Subnet mask update byte 1	Setting of byte 1 of the subnet mask in hexadecimal format (e.g."FF" for 255.255.255.0)
		b2	00..FF	Subnet mask update byte 2	Setting of byte 2 of the subnet mask in hexadecimal format (e.g. "FF" for 255.255.255.0)
		b3	00..FF	Subnet mask update byte 3	Setting of byte 3 of the subnet mask in hexadecimal format (e.g. "FF" for255.255.255.0)
	Sr	-	-	Subnet mask reset to factory setting	Reset subnet mask to factory default setting (255.255.255.0)

Table 4.9 IP address menu

Example configuration of subnet mask

In this example the subnet mask is changed from 255.255.255.0 to 122.255.255.0.

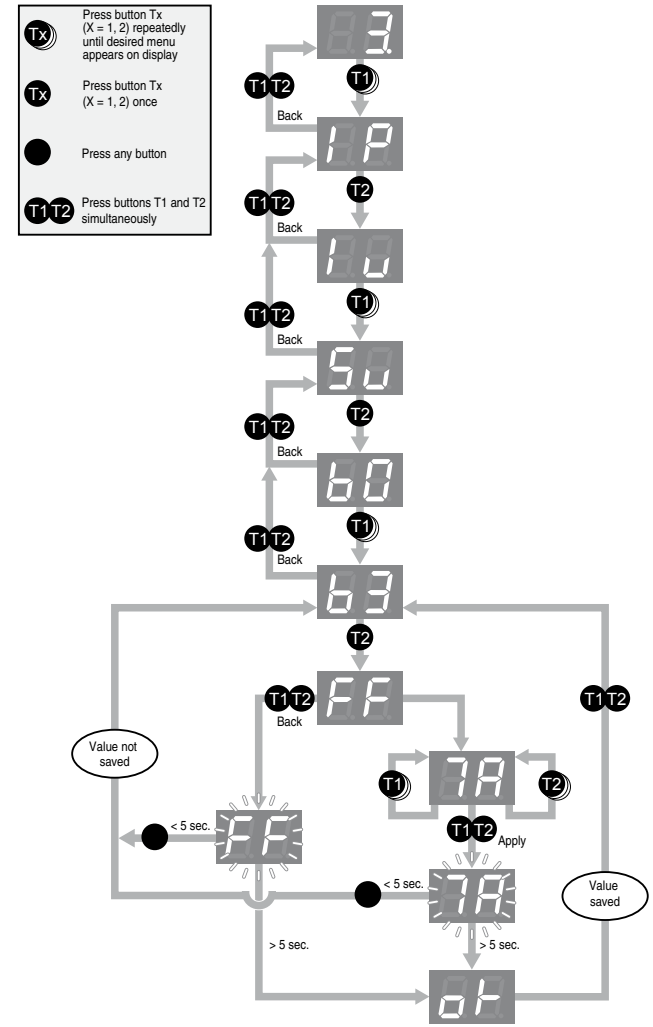


Figure 4.2 Example configuration of subnet mask

NOTE:

• During the flash phase after step 7 the save operation can be aborted by pressing any button without the setting being applied. Otherwise the new value is saved after five seconds.

• Without a restart of the control electronics a changed IP address is not applied.

4.4.5 Field bus address menu (Fb)

The functions available under this menu item depend on the device expansion option. For detailed information refer to the relevant specification.

Menu level 1	Menu level 2	Parameter	Value range	Meaning	Explanation
Fb	Ad	-	00..xx *or* - -	Field bus address	Setting of field bus address (only when field bus option used), otherwise display "- -" *(The maximum programmable value depends on the option)*
	Po	-	0..3 *or* - -	Transmit power	Setting of fibre-optic power output (only with SERCOS II option), otherwise display "- -"

Table 4.10 Field bus address menu

Example configuration of field bus address

In this example the field bus address is changed from 1 to 23.

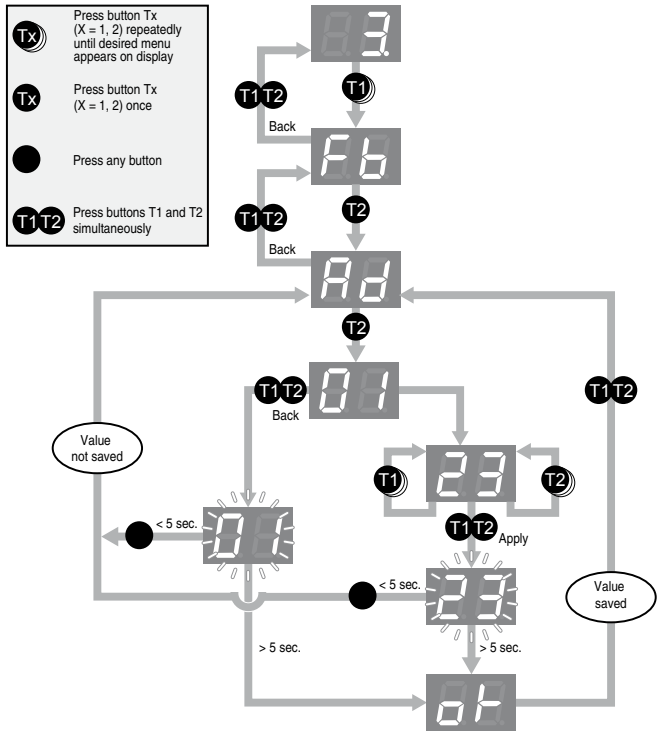


Figure 4.3 Example configuration of field bus address

Release for field test only

4.4.6 Firmware update with MMC card

The MMC card can be used to perform a firmware update for the ServoOne. For this, the HEX file of the update firmware must be copied under the name “main.hex” to the “\Firmware\” folder in the root directory of the MMC card.

Connect the preconfigured MMC card to the ServoOne. Then perform a reset of the 24 V DC control supply by pressing both buttons (T1 and T2) simultaneously. When the display shows the code “c1” you can release the buttons.

The progress of the firmware update is indicated on the display by a flashing dot after D2 and consecutively by "c1" ... "c4". When the update has been completed successfully the new firmware starts up as normal. In the event of an error the code “cE” is displayed. In this case a reset of the 24 V DC control supply must be performed and the download repeated.

5. Diagnostics

5.1 Status display on device

The device states are displayed on the device by way of the 7-segment display.

5.1.1 Device states

Display	System state
88.	Device in reset state
b0	Self-initialization on device start up
S1 *)	Not ready to switch on (no DC-link voltage) [1]
S2 *)	Start inhibit (DC link OK, power stage not ready) [1]
b3	Ready (power stage ready)
b4	Switched on (drive powered)[2]
b5	Drive ready (power applied to drive and drive ready for reference input) [2]
b6	Quick stop [2]
b7	Error reaction active [2]

*) Not a "safe indication" as specified in EN 61800-5-2.
1) S. flashes when the STO (Safe Torque Off) function is active, display goes out when function is inactive.
2) The dot flashes when the power stage is active.

Table 5.1 Device states

5.1.2 Error display

The 7-segment display shows the specificerror codes. Each error code comprises the alternating sequence ►"Er" ►error number ►error location.

Display	Meaning
Er	Device error
↓ Display changes after approx. 1 s	
05	Error number (decimal) Example: 05 = Overcurrent
↓ Display changes after approx. 1 s	
01	Error location (decimal) Example: 01 = Hardware monitoring
↑ After approx. 1 s the display jumps to ER	

Table 5.2 Display of error code

NOTE:

- **Error reset**
  Errors can be reset according to their programmed reaction (ER) or only by a 24 V reset (X9/10) (ER.). Errors marked with a dot can only be reset when the cause of the error has been eliminated.
- **Error codes**
  For detailed information on the error codes and on error management refer to the "ServoOne Application Manual".

ID no.: 1101.20B.2-00 Date: 01/2011

5.2 Status and error display in DM5

Click the "Drive status" button on the DM5 header to open the drive status window.

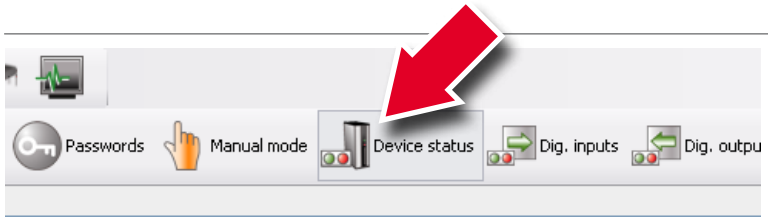


Figure 5.1 "Drive status" button on header

Click the "Error history" button to call up information on the last 20 occurring errors.

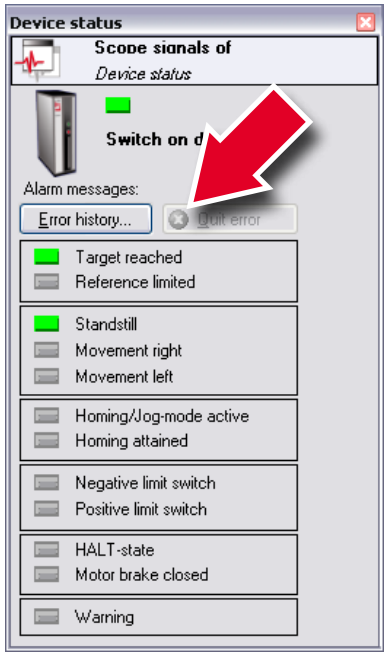


Figure 5.2 "Drive status" window

When an error occurs a pop-up window immediately appears showing more details about the current error.

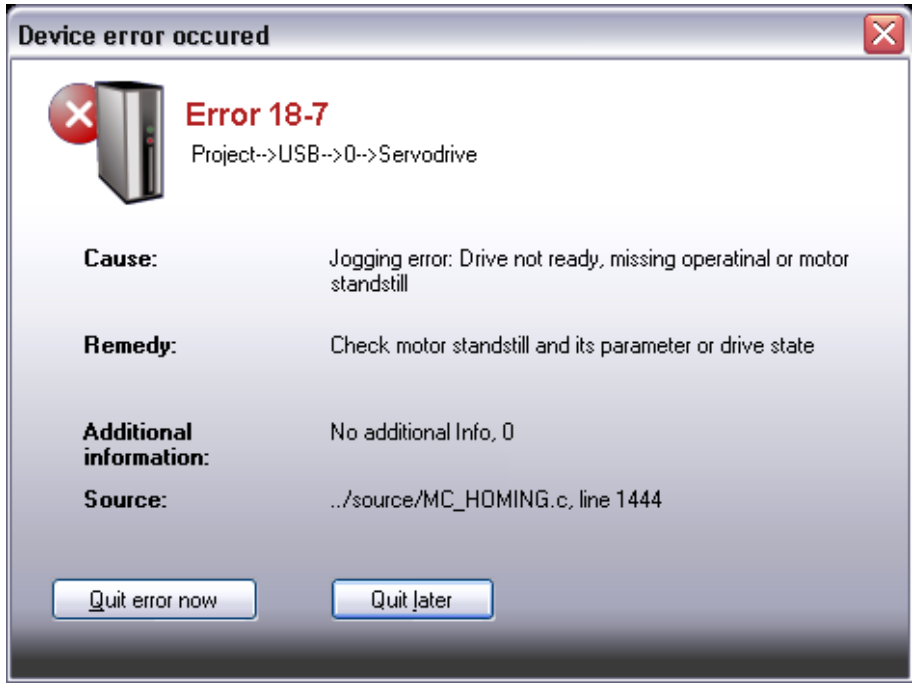


Figure 5.3 Error message

Parameter 31 "Alarms & warnings (Details)" gives detailed information about occurring errors and warnings.

1. In the "Project" window at the top in the header area select "Number search" and in the search box enter the number "31".
2. Then, in the project tree which opens up, double-click on the lowest level, "Alarms & warnings (Details)".

NOTE: More detailed information on parameter 31 can be found in the ServoOne Application Manual.

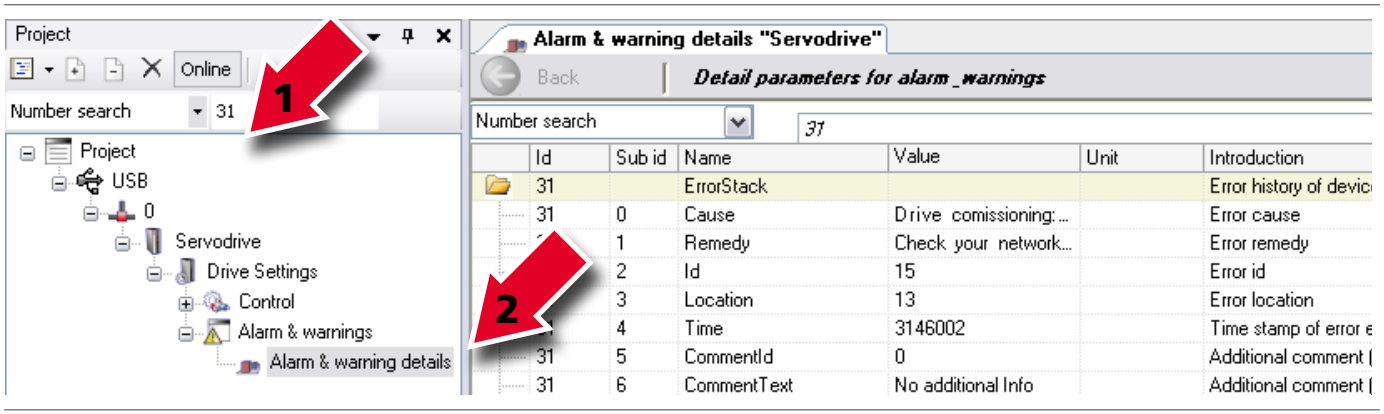


Figure 5.4 Parameter 31 "Alarms & warnings (Details)"

5.3 Helpline/Support & Service

Our Helpline can provide you with fast, targeted assistance if you have any technical queries relating to project planning or commissioning of the drive unit. To that end, please collect the following information prior to making contact:

1. Type designation, serial number and software version of the devices (see software rating plate)
2. DriveManager version in use (menu: ►Help ►Information... ►Version)
3. Displayed error code (on 7-segment display or DriveManager)
4. Description of the error symptoms, how it occurred and relevant circumstances
5. Save device settings to file in DriveManager
6. Name of company and contact, telephone number and e-mail address

The Helpline is available by phone, e-mail, or on the Internet:

Service hours:	Monday to Friday 8 a.m. to 5 p.m. (CET)
Phone:	+49 6441 966-180
E-mail:	helpline@lt-i.com
Internet:	http://drives.lt-i.com ►Support & Service ►Trouble Ticket

If you need further assistance, our specialists at the Support & Service Center will be happy to help.

Service hours:	Monday to Friday 8 a.m. to 5 p.m. (CET)
Phone:	+49 6441 966-888
E-mail:	service@lt-i.com

NOTE: If you need more detailed assistance and advice, you will find all the services we offer in the "Support & Service" order catalogue. You can download the order catalogue from the "Support & Service" section of our website at http://drives.lt-i.com.

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6. Safe Torque Off (STO)

6.1 Danger analysis and risk assessment

Users of the safety function (STO) must comply with the latest applicable version of the Machinery Directive 2006/42/EEC.

The manufacturer or its representative is obliged to undertake a danger analysis (in accordance with the applicable Machinery Directive) before the market launch of a machine. An analysis of hazards posed by the machine must be conducted and appropriate measures instigated to reduce/eliminate such hazards. With the danger analysis all prerequisites for establishing the required safety functions are fulfilled.

ATTENTION

- The ServoOne safety function "Safe Torque Off (STO)" has been approved by the TÜV-Rheinland accredited certification body. This certification is currently still in preparation. Conformance to parts of EN ISO 13849-1, EN 62061, EN 61800-5-2 and EN 61508 is ensured.
- The acceptance applies to drive controller types as set out in the tables B.1 to B.10 as well as to sizes BG1-BG4 as from serial number: 072900001. For size BG5+6a from serial no. 081750001.
- The operator of the safety-related system is trained in accordance with his/her state of knowledge, appropriate to the complexity and safety integrity level of the safety-related system. This training includes the study of essential features of the production process and knowledge of the relationship between the safety-related system and the equipment under control (EUC).

6.2 Definition of terms

STO = Safe Torque OFF

With the safety function STO the power supply to the drive is safely interrupted (no electrical isolation). The drive must not be able to generate a torque and so perform any hazardous movement. The standstill position is not monitored.

The "STO" function conforms to stop category 0 according to EN 60204-1.

Restart inhibit

The restart inhibit prevents enabling of the evaluation unit (STO) after a shutdown following a change of machine mode or after changing the method of confirmation. The restart inhibit is only cancelled by an external command (such as the On button, or in LTi drive controllers the ENPO).

Emergency stop

In accordance with the national and European preface to EN 60204-1, electrical equipment may also be used for emergency stop devices provided they comply with relevant standard, such as IEC 61508. "STO" can thus be used for emergency stop functions.

NOTE: The term "emergency stop device" has been replaced by the new term „action in case of emergency". The term "emergency stop" has been replaced by "shutdown in case of emergency (emergency stop)" – see paragraph 9.2.5.4.2 in EN 60204-1.

EN ISO 13849-1: 2008

Safety of machines, safety related parts of controls.

The EN ISO 13849 standard emerged from EN 954-1, supplemented by the aspects of quality management and reliability.

EN 62061: 2005

Safety sector standard for machinery, originating from IEC 61508

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IEC 61508: 2010

International basic safety standard specifying the status of safety technology in all its aspects.

EN 61800-5-1: 2007, EN 61800-5-2: 2007

Electrical drives with variable speed. Part 5-1: Requirements concerning electrical, thermal and function safety.

EUC (Equipment Under Control)

EUC system:
A system that responds to the input signals from the process and/or a user and generates output signals which enable the EUC to work as desired.

EUC equipment:
Equipment, machine, apparatus or plant used for the manufacture, production and processing, transportation, medical or other activities.

EUC - risk:
Risk resulting from the EUC or its interaction with the EUC operating equipment.

PFH (Probability of dangerous Failure per Hour)

In respect of a hazardous random hardware failure.

Safety function

Function performed by an E/E/PE (electrical/electronic/programmable electronic) safety-related system, a safety-related system of other technology or external equipment for risk minimization, with the goal of attaining and maintaining a safe state for the EUC, taking into account a particular undesired event.

Validation

Affirmation that the special requirements for a certain purpose of use are fulfilled by investigation and the submission of objective proof.

Validation describes the activity to prove that the safety-related system under investigation meets the specified safety requirements of the safety-related system in every respect, before or after installation.

Positive opening operation of a contact element

Symbol for positive opening operation according to EN 60947-5-1 annex K 

In a positive opening operation of a contact element, the contact separation is achieved as a direct result of a certain movement of the actuating element caused by non-elastic links (no springs).

Safety circuit

A safety circuit is designed with two channels and has been approved by accredited testing bodies on the basis of the standards. There is a large number of manufacturers offering a vast variety of safety circuits for various applications.

6.2.1 Function description

The ServoOne servocontrollers support the "STO" (Safe Torque Off) safety function in accordance with the requirements of EN 61800-5-2, EN ISO 13849-1 "PL e" and EN 61508 / EN 62061 "SIL 3".

The "STO" safety function to EN 61800-5-2 describes a safety measure in the form of an interlock or control function. "Category 3" signifies that the safety function will remain in place in the event of a single fault.

The safety-related parts must be designed in such a way that:

- a single fault in any of the said parts does not result in loss of the safety function and
- the single fault is detected on or before the next request to the safety function.

For the "STO" function the servo controllers are equipped with additional logic circuits and a feedback contact. The logic cuts the power supply to the pulse amplifiers to activate the power stage. In combination with the controller enable "ENPO" the system uses two channels to prevent the motor creating a torque.

6.2.2 Fundamentals

Always draw up a validation plan. The plan specifies which tests and analyses were used by you to determine compliance of the solution with the requirements of the application.

NOTE: Switch cabinet mounting with IP54 protection is mandatory.

DANGER FROM ELECTRICAL TENSION!

- If the servocontroller is in the "STO" state all motor and DC link voltage cables conduct dangerous voltages against protective conductors.
- With the "STO" function no "shutdown of voltage in case of emergency" is possible without additional measures. There is no electrical isolation between the motor and servocontroller! This means there is a risk of electric shock or other electrical hazard.

DANGER FROM AXIS MOVEMENT ON THE MOTOR!

- If an external effect of forces can be expected in "STO" safety function, such as with a suspended load, this motion must be reliably prevented by additional measures, such as by two brakes, safety bolts or a clamping device with brake.
- Despite correct shutdown, a short-circuit in each of two remote branches of the power section may electrically trigger an axis movement by max. 180°.

NOTE: The safety circuitry connected to the ServoOne should be designed in such a way that in case of a loss of electrical supply the safe state of the machine can be reached or maintained.

6.2.3 Overview of "STO" connections

ServoOne offers a separate input for the "STO" request, a facility to deactivate the restart inhibit and a separate relay contact for feedback.

Des.	Term.	Specification		Isolation
Digital inputs				
ENPO (STO)	X4/10	• Disable restart inhibit (STO) and enable power stage = High level • "Request STO" input = Low level • OSSD-capable • Reaction time approx. 10ms • Switching level Low/High: ≤4.8 V / ≥18 V • $U_{IN\ max}$ = +24 V DC +20 % • I_{IN} at +24 V DC = typ. 3 mA		Yes
STO "Safe Torque Off"				
ISDSH (STO)	X4/22	• "Request STO" input = low level • OSSD-capable • Frequency range <500 Hz • Switching level Low/High: <4.8 V / >18 V • $U_{IN\ max}$ = +24 V DC +20 % • I_{IN} at +24 V DC = typ. 3 mA		Yes
RSH RSH	X4/11 X4/12	Diagnose STO, both tripping channels active, one NO contact with auto-matically resetting circuit-breaker (polyswitch) • 25 V / 200 mA AC, cos φ = 1 (AC1) • 30 V / 200 mA DC, cos φ = 1 (DC1)	X4/12 X4/11	Yes

X4

REL	24	12	RSH
REL	23	11	RSH
ISDSH	22	10	ENPO
ISD06	21	9	OSD02
ISD05	20	8	OSD01
ISD04	19	7	OSD00
ISD03	18	6	ISA1-
ISD02	17	5	ISA1+
ISD01	16	4	ISA0-
ISD00	15	3	ISA0+
+24V	14	2	+24V
DGND	13	1	DGND

Table 6.1 Terminal assignment X4

6.2.4 Wiring and commissioning

For the "STO" function the servocontrollers are equipped with additional logic circuits and a feedback contact. The logic cuts the power supply to the pulse amplifiers to activate the power stage. In combination with the controller enable "ENPO", the system uses two channels to prevent the motor creating a torque.

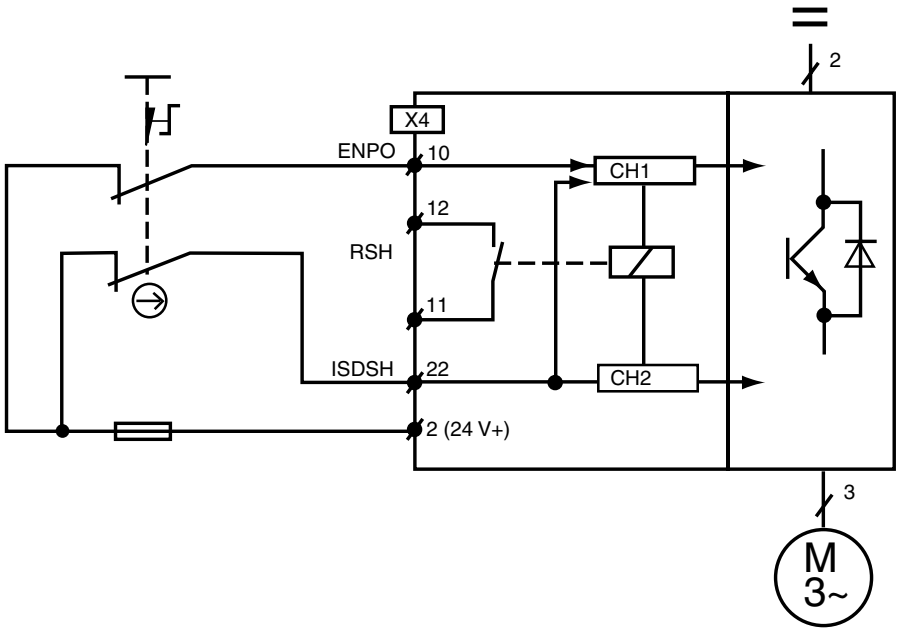


Figure 6.1 "STO" selection of function via switch with two NC contacts (positively operated)

ENPO	ISDSH	STO	Restart inhibit	Controller state	RSH[1)]
L	L	ON	ON	Power stage disabled via two channels	High
H [3)]	H [3)]	OFF	OFF	Power stage ready	Low
(L) ⇨ H [2)]	(L) ⇨ H [2)]	OFF	OFF	Power stage ready	Low
H	(H) ⇨ L	ON	ON	Power stage disabled via two channels	High
(H) ⇨ L	H	OFF	OFF	Power stage disabled via one channel	Low
(L) ⇨ H	H	OFF	OFF	Power stage ready	Low

( ) Previous status
1) 3 x 10^6 switching cycles at 200 mA (resting: NO contact)
2) In order to deactivate the restart inhibit the control signals must be simultaneously (ENPO max. 5 ms before ISDSH) set to High (H), or ISDSH must be reliably set to High (H) before ENPO.
3) This only applies when STO has been disabled by the process described in "2)"

Table 6.2 Switching response of the safety function

NOTE: The plausibility between input signals (ENPO, ISDSH) and feedback (RSH) must always be monitored.

6.2.5 Testing the STO function

The applied control signals "ISDSH" and "ENPO" must always be checked by the operator or a higher-level control for plausibility to the feedback (RSH).

The occurrence of an implausible status is a sign of a system fault (installation or servo-controller). In this case the drive must be switched off and the fault rectified.

ATTENTION! The "STO" (Safe Torque Off) function must generally be checked for correct functionality:

- after initial commissioning;
- after any modification of the system wiring;
- after replacing one or more items of system equipment.

NOTES:

- There is no protection against unexpected restarting after re-establishing the electrical power supply in the illustrated example circuit, unless an external circuit is used (figure 6.1). If ENPO and ISDSH are High when reconnecting the power supply (see table 6.2), the axle may start up if autostart is programmed. The connected safety circuit on the machine must ensure that the ServoOne (the SRP/CS) can attain and maintain the safe state of the machine.
- If the switch and drive controller are installed in separate locations, it must be ensured that the cables from NC contact 1 to ENPO (STO) and from NC contact 2 to ISDSH (STO) are wired separately, or that possible faults are prevented by using a protective tube for example.
- In order to cancel the STO safety function and deactivate the restart inhibit, the ISDSH signal must be set to High before the ENPO signal, or simultaneously with it.

6.3 Safety acceptance tests

STO shutdown acceptance test

Safety characteristics to EN ISO 13849:
PL: .....e
Category: 3
MTTFd: .....7.105 a

Safety characteristics to EN 62061 / EN 61508:
SIL: 3
HFT: 1
PFH: .....1,73 x 10^{-9} 1/h

Restart inhibit acceptance test

Safety characteristics to EN ISO 13849:
PL: .....e
Category: 3
MTTFd: .....7.105 a

Safety characteristics to 62061 / EN 61508:
SIL: 3
HFT: 1
PFH: .....1,73 x 10^{-9} 1/h

7. Operation with servocontroller as supply

NOTE: **Project planning**
For assistance in choosing the optimum operation mode (with supply unit or servocontroller) refer to appendix, starting on page 63.

ATTENTION! **Refer to the servocontroller operation manual!**
When constructing a multi-axis system with servocontrollers as the supply source, be sure to refer to the "ServoOne Operation Manual – Single-Axis System" (ID no. 1100.00B.x).

7.1 Layout of devices and components

The placement of components in the switch cabinet is a key factor in operating the plant and machinery of the multi-axis system without disturbance. So be sure to observe the following points when planning:

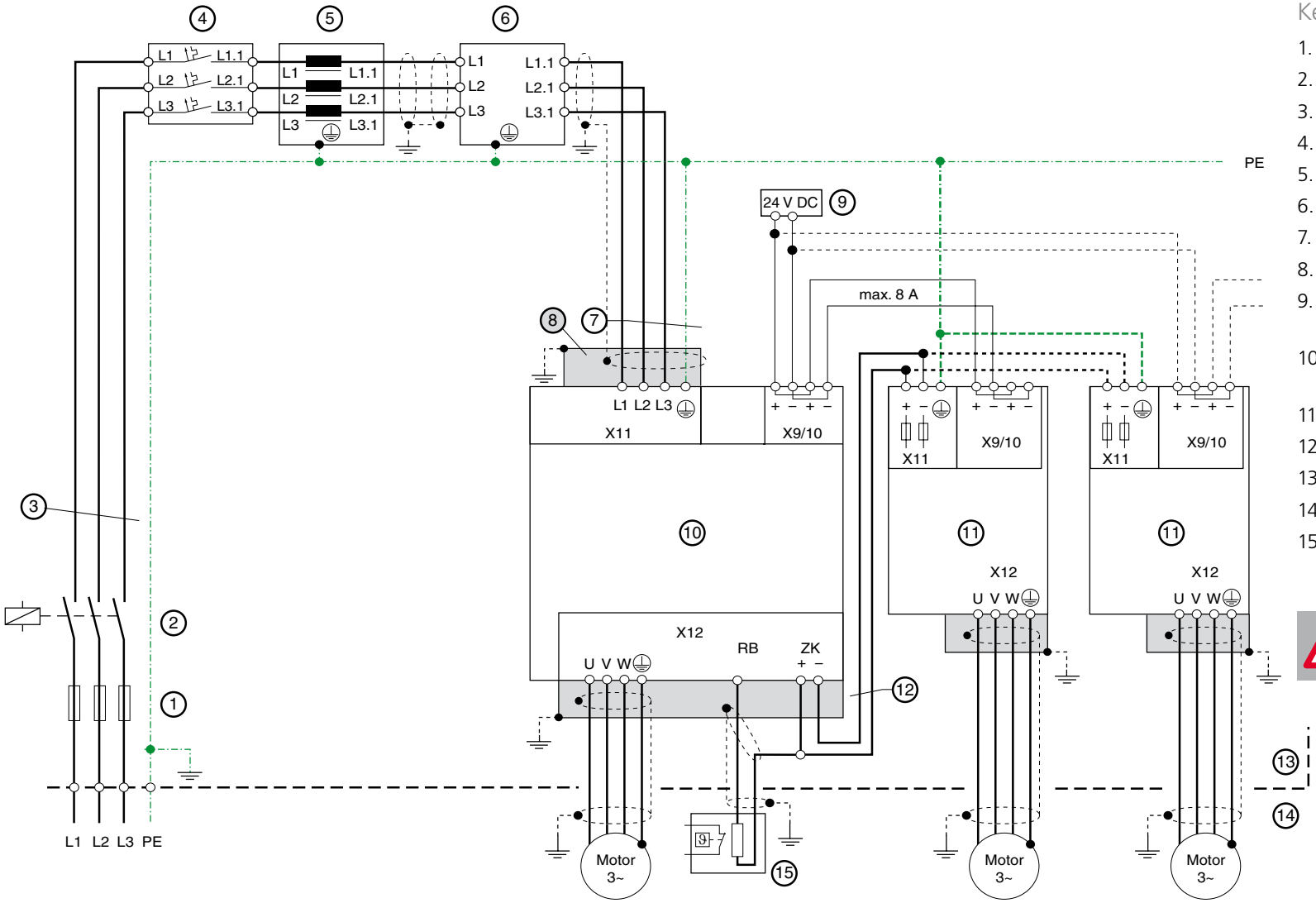
- The "Notes for installation“ on page 13 and the "Notes for installation" on pages 19 ff. apply without restriction.

Also note the following points:

- Assess the assemblies used in terms of their electromagnetic compatibility.
- Then divide the switch cabinet into zones of differing power and interference levels and group the modules accordingly.
- Keep units susceptible to interference at a minimum clearance of 0.2 metres from the following components:
  - Drive controller
  - Input and output reactors
  - Transformers
  - Mains, motor, DC power supply and braking resistor cables (even if shielded)
  - Relays and contactors (even if interference-suppressed)
- The mains filter must be sealed tight as far as possible at the servocontroller (BG1 to BG4) or be mounted on the backing plate across a wide area at the feed-in point (BG5 to BG7).
- The backing plate must have a low-resistance connection to the central grounding point.
- No unshielded cables may be routed on the mains input side of the filter, to prevent interference.
- Do not use fluorescent lamps in switch cabinets, as they emit high-frequency interference.

ATTENTION! **Device protection**
When installing a multi-axis system with a servocontroller as the supply, note the following points relating to device protection:

- **Mains fuses**
  The mains fuses should always be installed additional to the motor protection switch and prevent destruction of the device (e.g. in the case of a component defect or overload). Use mains fuses (duty class gG) to isolate all poles of the drive controller from the mains supply. For more details refer to ServoOne Operation Manual – Single-Axis System (ID no. 1100.00B.x) in the "Electrical installation" section.
- **Motor protection switch**
  The motor protection switch should always be installed additional to the mains fuses. It serves as an overload protector for the device, line reactor and mains filter in the range up to the permissible overload. The rated current of the motor protection switch ("Power switch for system and motor protection", trip class 10, SIEMENS series SIRIUS 3RV10 or SIRIUS 3RV20) should be selected according to the lowest rated current $I_{rated\ (f\_sw\ and\ U\_mains)}$ of the components used (line reactor, mains filter, servocontroller).
- **Braking resistor**
  The braking resistor of the servocontroller should be dimensioned such that the total regenerative power of the multi-axis system can be dissipated. When dimensioning the connecting cables of the braking resistor, ensure that the mains-side protective devices are safely tripped in the event of a fault. Note that the ratio of the currents $I_{DC\ bus\ eff}$ / $I_{mains\ side\ eff}$ = √(3/2).

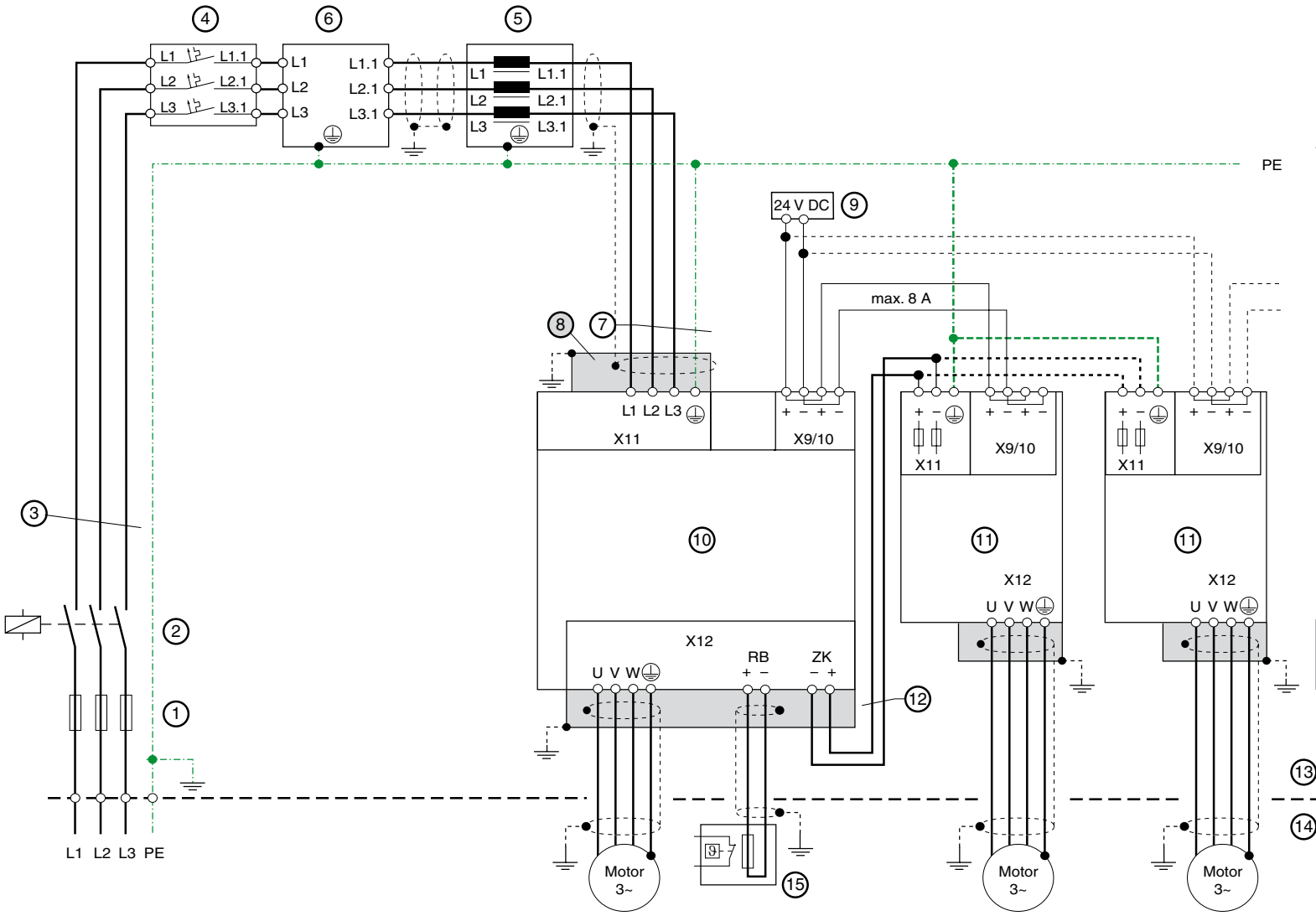


Key

1. Mains fuses [1)]
2. Mains supply/emergency stop
3. Short-circuit-proof cables
4. Motor protection switch [1)]
5. Line reactor
6. Mains filter
7. AC power connection
8. Shields (grey)
9. External 24 V DC control supply (fuse-protected)
10. ServoOne servocontroller (BG1 to BG4)
11. ServoOne DC axis controller
12. DC link
13. Switch cabinet
14. Field
15. Braking resistor[1)]

[1)] ATTENTION:
Observe the requirements for device protection on page 57!

Figure 7.1 Overview - Connection diagram for operation with supply by servocontroller (BG1 to BG4)

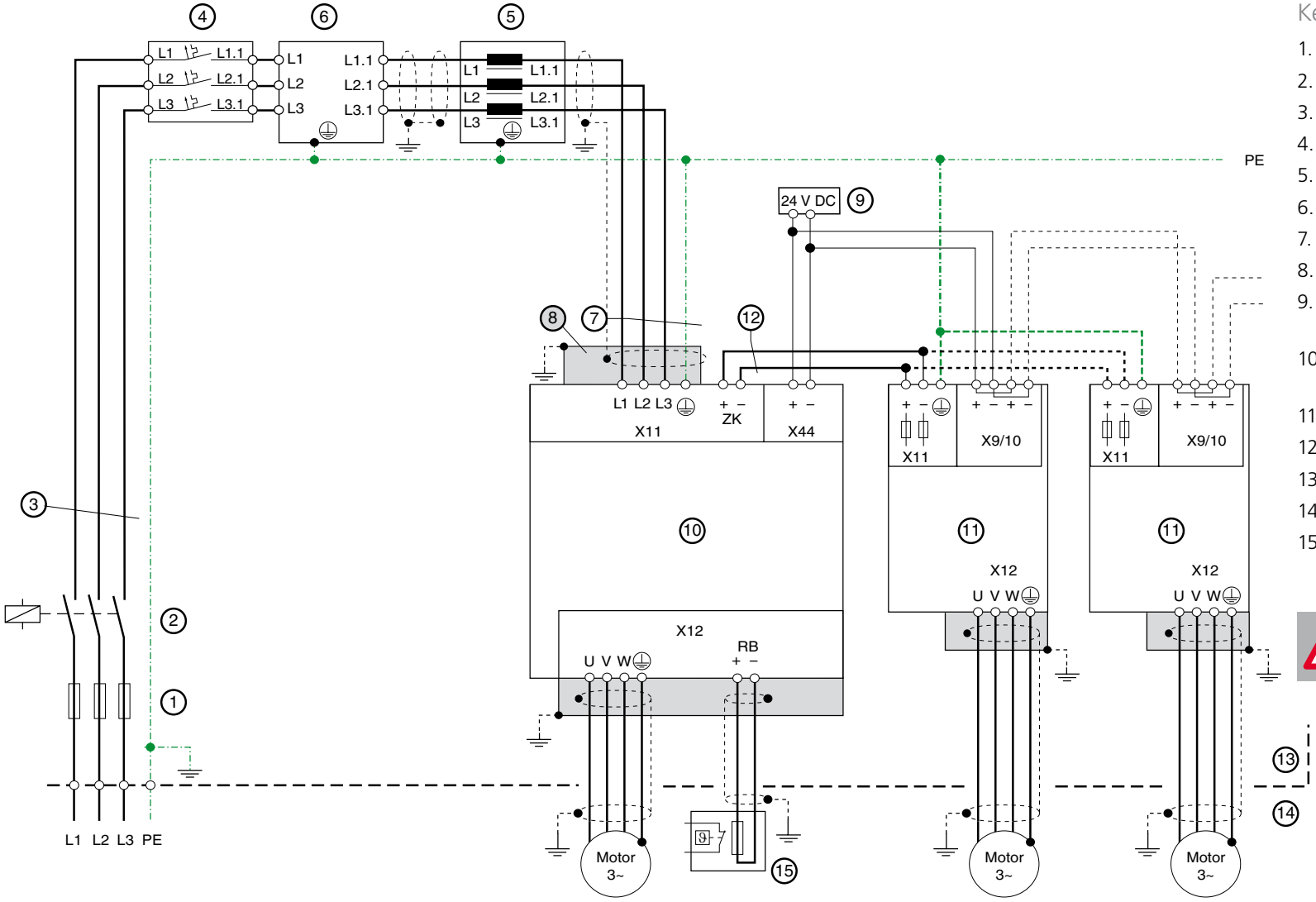


Key

1. Mains fuses [1)]
2. Mains supply/emergency stop
3. Short-circuit-proof cables
4. Motor protection switch [1)]
5. Line reactor
6. Mains filter
7. AC power connection
8. Shields (grey)
9. External 24 V DC control supply (fuse-protected)
10. ServoOne servocontroller (BG5 to BG6a)
11. ServoOne DC axis controller
12. DC link
13. Switch cabinet
14. Field
15. Braking resistor[1)]

[1)] ATTENTION:
Observe the requirements for device protection on page 57!

Figure 7.2 Overview - Connection diagram for operation with supply by servocontroller (BG5 to BG6a)



Key

1. Mains fuses [1)]
2. Mains supply/emergency stop
3. Short-circuit-proof cables
4. Motor protection switch [1)]
5. Line reactor
6. Mains filter
7. AC power connection
8. Shields (grey)
9. External 24 V DC control supply (fuse-protected)
10. ServoOne servocontroller (BG7)
11. ServoOne DC axis controller
12. DC link
13. Switch cabinet
14. Field
15. Braking resistor[1)]

[1)] ATTENTION:
Observe the requirements for device protection on page 57!

Figure 7.3 Overview - Connection diagram for operation with supply by servocontroller (BG7)

7.2 Operation with servocontroller as supply

NOTE: The switch cabinet layout shown here is intended as an illustration only. It does not guarantee general suitability for a specific application or compliance with relevant directives. You should check and assess the layout you are planning in each individual case with regard to the specific application and compliance with locally applicable directives. LTi DRiVES can provide no guarantee as to the applicability of the following switch cabinet layout.

ID number	Meaning
1	Mains cable
2	Main switch
3	Fuse
4	Mains filter
5	*not present*
6	Mains contactor
7	*not present*
8	*not present*
9	Servocontroller for co-supply of the DC axis controllers
10	DC axis controller
11	DC link power supply to axis controllers
12	Braking resistor external to servocontroller
13	Motor cables
14	Control (higher-level)

Table 7.1 Key to switch cabinet layout

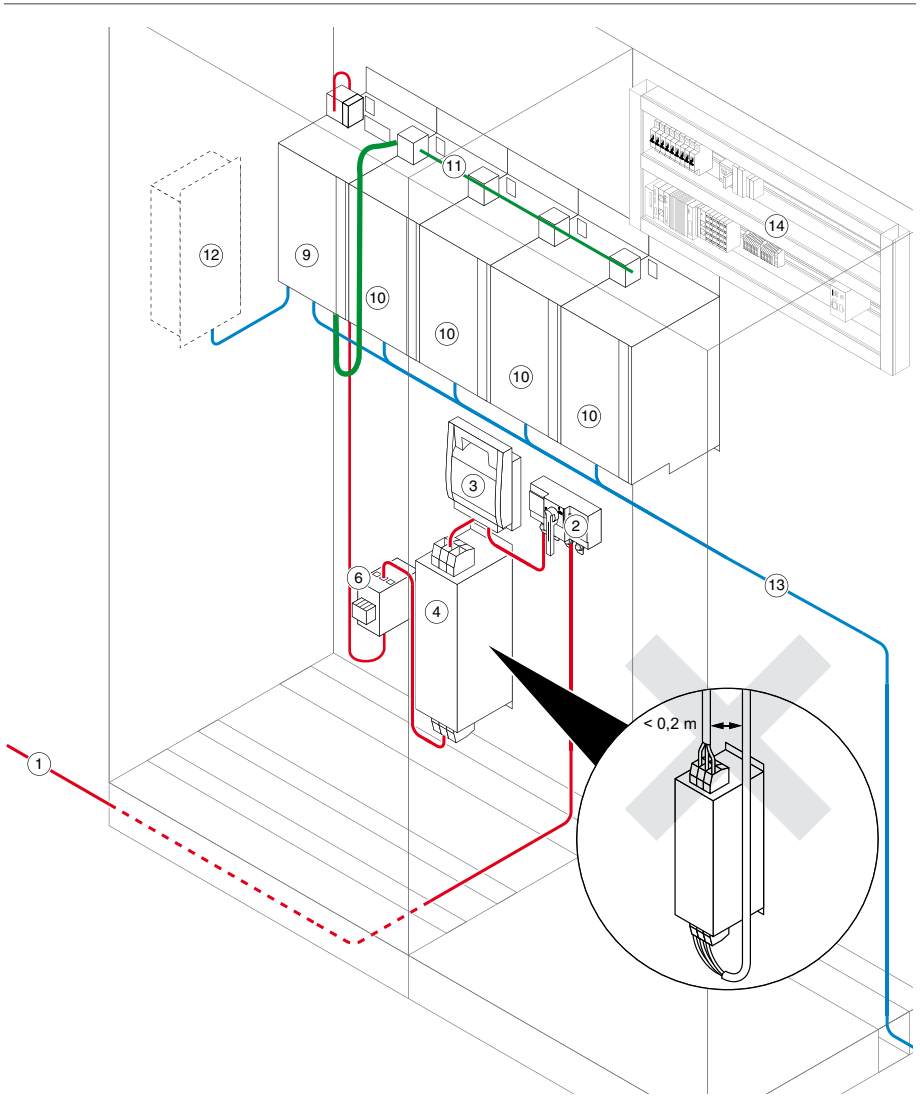


Figure 7.4 Switch cabinet layout, multi-axis system with supply by servocontroller (as from BG5)

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Space for your own notes

A. Project planning

A.1 Overview and comparison of multi-axis systems

This overview presents the two possible system variants for LTi multi-axis systems: "Operation with supply unit" and "Operation with servocontroller as supply". It will help you to judge the optimum variant for your application. Aspects such as available installation space, complexity of installation, acquisition and operating cost are considered.

ATTENTION!

- The variants set out in this section relate solely to devices and components of the LTi DRiVES ServoOne product family (excluding ServoOne junior). Operation with devices or components from other manufacturers or product families is not permitted!
- For each application, a number of specific factors, such as total power output and simultaneity, must be individually considered in order to ensure safe system operation.
- You should always consult LTi's Project Support advisors when planning your application. They will be able to balance all the parameters using a powerful project planning software program.
- Commissioning of a ServoOne multi-axis system should only be undertaken following dimensioning by LTi's Project Support department!

A.2 Application examples

The ServoOne multi-axis systems are able to demonstrate their advantages over a conventional system comprising multiple servocontrollers particularly in applications which often feature regenerative operation. Depending on the length of the regenerative phases, and whether other system axes are in motorized mode during those phases, operation either with a supply unit or a servocontroller as the supply source may be preferable.

A.3 Operation with supply unit

In this system variant the DC-fed axis controllers are connected to a central supply unit.

Advantages

- Regenerative power from an axis is available to the other axes via the central DC link
- Surplus power in the DC DC link is fed back into the supply grid centrally via the supply unit
- Sinusoidal mains current with very low harmonics in motorized and regenerative mode
- Controlability of power factor to cos φ = 1 (reactive current compensation)
- Identical power values in motorized and regenerative mode
- The system can have more axes than in the case of supply with a servocontroller
- Depending on the configuration of the supply unit, all axes can be operated simultaneously at rated power
- Installation of the supply cables between the supply unit and axis controller is convenient and space-saving, using a through-going rail system (BG1 to BG5)
- The operating cost is below that of a system comprising a servocontroller or servocontrollers as the supply source
- Higher DC link voltage than with a corresponding AC feed, meaning smaller-sized motors can be used
- Loop-controlled DC link voltage, so mains voltage fluctuations no longer have to be allowed for in the system by way of a reserve
- Higher DC link voltage enables compensation for weak supply systems and maximum motor torques in the field-weakening range
- Full compensation for mains voltage drops based on the ability to increase voltage
- High dynamism based on rapid changes in power flux on the load side
- In case of power failure, braking is possible by way of built-in braking choppers

Disadvantages

- Due to the supply unit and its external circuitry, more space may be required than in operation with a servocontroller as the supply source or a system comprising servocontrollers.
- The investment cost is higher than that for a system comprising a servocontroller or servocontrollers as the supply source.

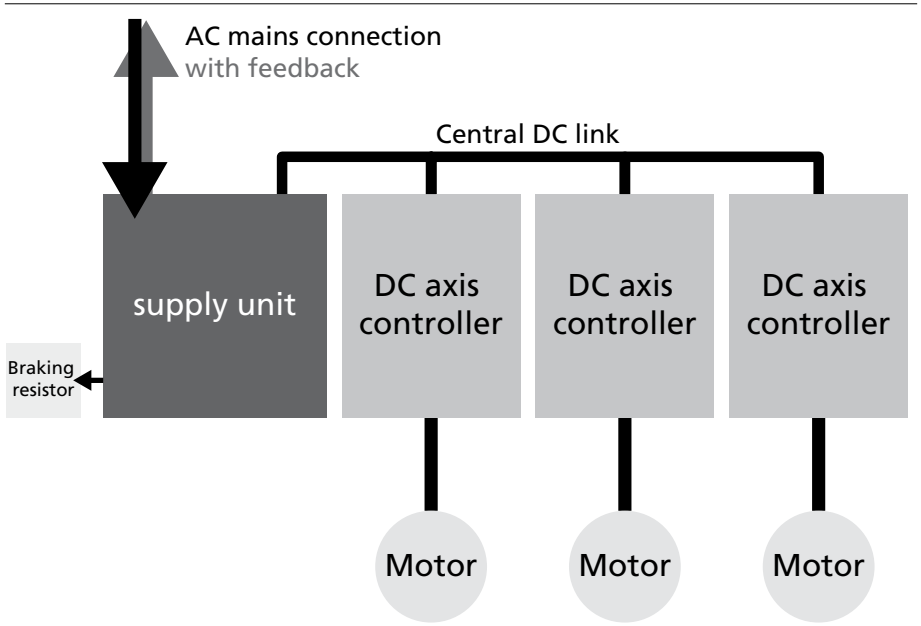


Figure A.1 Block diagram of a multi-axis system with supply unit and mains feedback

A.4 Operation with servocontroller as supply

Advantages

- The investment cost is lower than in operation with a supply unit
- As no additional supply unit is required, the space needed is usually less than in operation with a supply unit
- Regenerative power is available to the other axes via the central DC link
- Surplus power is dissipated centrally via the braking resistor of the servocontroller

Disadvantages

- In this system variant the full rated power can usually not be requested simultaneously on all axes, as otherwise the DC link of the AC-fed servocontroller may be overloaded
- The supplying servocontroller may need to be overdimensioned
- Regenerative power cannot be fed back into the supply grid, but can only be converted into heat by way of a braking resistor
- Similarly to the servocontroller, the braking resistor may need to be overdimensioned, as a result of which the heat it generates might necessitate additional effort and expense for installation and air-conditioning
- The operating cost is higher than that of a system comprising a servocontroller or servocontrollers as the supply source
- Lower DC link voltage than in operation with a supply unit
- Owing to the precharge capacitance, fewer DC axis controllers can be connected than in the case of the supply unit

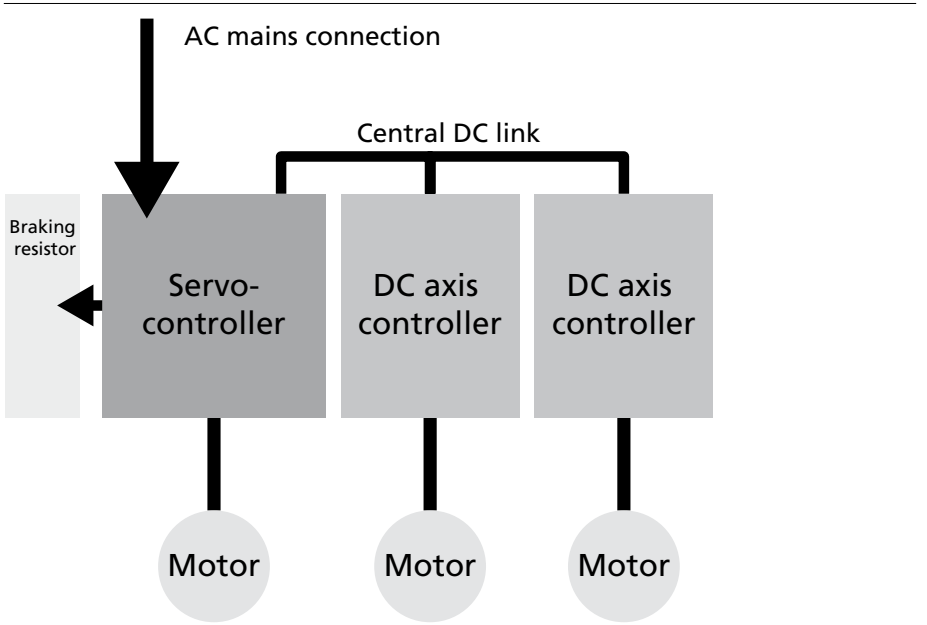


Figure A.2 Block diagram of a multi-axis system with servocontroller as supply

A.5 Functional comparison

The technical and functional differences between operation with a servocontroller as the supply source and operation with a supply unit are compared here as an aid to selection.

Feature	Servo-controller as supply	Supply unit
Operation on a wide variety of mains voltages worldwide possible	○ 1)	●
Regenerative (sinusoidal)		●
Operation possible with any simultaneity factor	○	●
DC DC link via rail system (BG1 - BG5)	○	●
Power equalization by central DC DC link	●	●
Controlled shutdown in case of power failure	●	●
Requires external step-up and input reactors		●
Requires external braking resistor	●	○ 2)
Air cooling	●	●
Liquid cooling	●	●
Higher DC link voltage (650 V/770 V)		●
Reactive current compensation		○
EtherCAT, SERCOS II & III, PROFINET IRT, VARAN, CANopen, PROFIBUS-DPV1	●	●
Sin/Cos encoder, TTL encoder simulation/encoder	●	●

● = *applicable*, ○ = *partially applicable*
1) With autotransformer
2) For emergency running in case of power failure

Table A.1 Functional comparison

A.6 Financial calculation

Alongside the functional advantages, a multi-axis system also offers ecological and financial benefits based on the energy saving. Depending on the application, higher investment cost can be amortized quickly thanks to the reduced power consumption.

Example with three axes

	Single AC axes	Servocontroller as supply	Supply unit
Components	3x SO84.024.0 3x line reactor 3x braking resistor	2x SO84.024.1 1x SO84.060.0 with - line reactor - braking resistor	3x SO84.024.1 1x SO84.076.S 1x LCL set
Investment cost	100 %	108 %	163 %
Energy saving 1)	-	5 %	10 %
Electricity price	0.1079 €/kWh 2)		
Operating time	16 hours per day, 20 days per month		
Amortization of additional cost after	**-**	**7 months**	**27 months**

1) Compared to single AC axes; this value need to be determined individually for each application
2) German Federal Association of Energy Consumers; electricity price comparison I/2010 for small and medium-sized industrial customers; average electricity price, federal states in former West Germany

Table A.2 Financial calculation for three axes

Example with six axes

	Single AC axes	Servocontroller as supply	Supply unit
Components	6x SO84.024.0 6x line reactor 6x braking resistor	5x SO84.024.1 1x SO84.143.0 with - line reactor - mains filter - braking resistor	6x SO84.024.1 1x SO84.170.S 1x LCL set
Investment cost	100 %	115 %	142 %
Energy saving 1)	-	5 %	10 %
Electricity price	0.1079 €/kWh 2)		
Operating time	16 hours per day, 20 days per month		
Amortization of additional cost after	**-**	**13 months**	**18 months**

1) Compared to single AC axes; this value need to be determined individually for each application
2) German Federal Association of Energy Consumers; electricity price comparison I/2010 for small and medium-sized industrial customers; average electricity price, federal states in former West Germany

Table A.3 Financial calculation for three axes

A.7 Dimensioning

This section summarizes how you can configure the ServoOne multi-axis system appropriately for your application. The configuration of a multi-axis system depends on a large number of parameters. The guidance provided in this section enables you to compile all the relevant data for the dimensioning of your specific application.

NOTE: Based on this data, the specialists in the LTi Project Support department will draw up a detailed dimensional calculation for you. You can reach Project Support on +49 6441 966-880, Monday to Friday, between 8 a.m. and 5 p.m. (CET).

For more information refer to our Support & Service catalogue, the latest version of which can be accessed on our website under ▶Support & Service ▶Services.

A.7.1 Calculating the required drive power per axis

Calculation of the drive power requires the following data for each rotary axis:

- Maximum torque
- Effective torque
- Maximum speed
- Gear ratio
  - Effective torque formula
    (with torque curves constant in each segment):

$$M_{eff} = \sqrt{\frac{\Sigma M_i^2 \cdot t_i}{T}}$$

  - Maximum torque formula:

$$M_{max} = M_{accel} + \frac{1}{i} \frac{1}{n_{gear}} M_{load}$$

$$M_{accel} = 2 \cdot \pi \frac{\Delta n}{\Delta t} \left(J_{motor} + \frac{1}{i^2} J_{load}\right)$$

Calculation of the drive power for linear motors requires the following data for each rotary axis:

- Maximum thrust
- Effective thrust
- Maximum feed rate

A.7.2 Selection of suitable gearing and motors

The gearing is selected depending on the application either to attain the maximum dynamism or for the most efficient possible continuous operation.

- Gear ratio formula (for optimum dynamism):

$$i = \sqrt{\frac{J_{load}}{J_{motor}}}$$

- Gear ratio formula (for effective utilization in continuous operation):

$$i = \frac{n_N}{n_{load}}$$

Motors are selected according to the following criteria:

- M_{max}
- n_{max}
- $M_{rated} > M_{eff}$

Specify the encoder system according to the requirements of your application in terms of absolute accuracy, repeatable accuracy, robustness and calculation of the machine zero:

- Resolver
- Sin/Cos encoder, single-turn
- Sin/Cos encoder, multi-turn

NOTE: For more detailed information on the encoder systems refer to the LSx servomotors order catalogue (ID no.: 0814.05B.x).

A.7.3 Selection of suitable axis controllers

When the motors have been selected, the matching axis controllers are selected according to the following criteria:

- Maximum current
- Rated current

NOTE: For the current data of the LSx motors refer to the LSx servomotors order catalogue (ID no.: 0814.05B.x).

A.7.4 Selection of suitable supply unit

ATTENTION! In all the following dimension calculations always also refer to the operation manual for the ServoOne supply unit (ID no. 1101.01B.x).

To determine the suitable supply unit, a power/time graph over a complete machine cycle must be available for all axes. Figure A.3 presents an example of one.

The power demand of each individual axis at every point in time is added together to produce the power/time graph for the supply unit. The following characteristic values for the supply unit can be derived from it:

- Nominal feed power
- Maximum feed power
- Nominal feedback power
- Maximum feedback power

If the simultaneity factor in the axis network is low, it may be possible to select the largest axis as the servocontroller and handle the feed for the entire axis network. Feedback into the supply grid is then not possible however. Regenerative power must be discharged by way of a braking resistor and converted into heat.

NOTE: If the supplying voltage grid fails, the supply unit's design means it is no longer capable of feedback. For this special emergency case we therefore recommend you use a braking resistor, with a power rated for this one braking action.

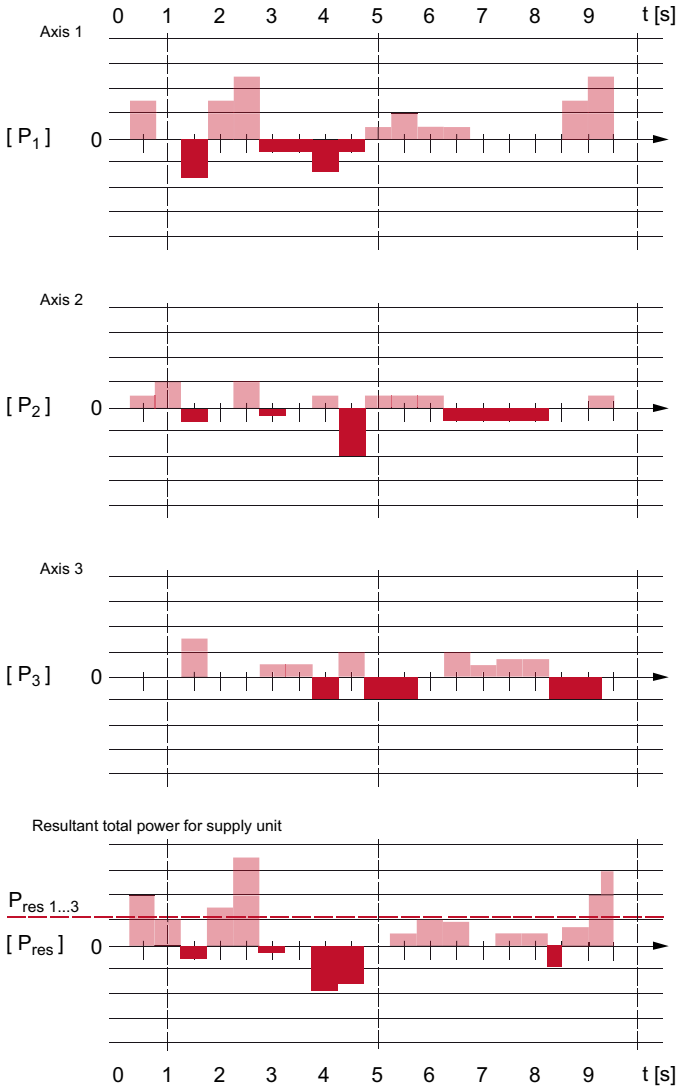


Figure A.3 Time/power graph with supply unit

The precharge circuit and DC link of the supply unit must not be overloaded. Consequently, the total power tap and total DC link capacitance of all axis controllers must not exceed the limit values of the supply unit. In this regard refer to tables A.4 and A.5:

Supply unit	Power output [wk]		DC link capacitance [µF]	Maximum precharge capacitance [µF]
	Continuous	Peak[1)]		
SO84.040.S	26	52	900	10000
SO84.076.S	50	94		
SO84.115.S	75	127	4240	20000
SO84.170.S	110	160		

1) For 10 s

Table A.4 Power output and capacitances of the supply units

DC axis controller	DC link capacitance [µF]	
	Air cooling	Liquid cooling
SO84.004.1	60	-
SO84.006.1	60	-
SO84.008.1	105	-
SO84.012.1	105	-
SO84.016.1	288	288
SO84.020.1	288	288
SO84.024.1	504	504
SO84.032.1	504	504
SO84.045.1	430	900
SO84.060.1	900	900
SO84.072.1	900	900
SO84.090.1	1060	2120
SO84.110.1	2120	2120
SO84.143.1	3180	4240
SO84.170.1	4240	4240

Table A.5 DC link capacitances of the DC axis controllers

Calculation example: Feed with supply unit

Two DC axis controllers SO84.024.1, two DC axis controllers SO84.060.1 and one DC axis controller SO84.090.1 (air-cooled) are to be connected to a supply unit SO84.115.S.

Calculation: 1 x 4240 µF + 2 x 504 µF + 2 x 900 µF + 1 x 1060 µF = 8108 µF

Result: The supply unit is adequately dimensioned with a maximum precharge capacitance of 9200 µF.

NOTE: Note that not only the DC link capacitances of the DC axis controllers, but also of the supply unit, need to be considered.

A.7.5 External components

When using a supply unit you will need additional components:

- Mains connection set (comprising mains filter, input reactor including capacitor, step-up reactor, EMC fixings)

See ServoOne system catalogue (ID no.: 1100.24B.x).

A.7.6 Selection of suitable servocontroller as supply

If the simultaneity factor in the axis network is low, it may be possible to select the largest axis as the servocontroller and handle the feed for the entire axis network. To determine the suitable servocontroller, a power/time graph over a complete load cycle must be available for all axes. Figure A.4 presents an example of one.

The power demand of each individual axis (including the servocontroller axis) at every point in time is added together to produce the total power/time graph. The following characteristic values can be derived from it:

- Nominal input power of the servocontroller axis
- Maximum input power of the servocontroller axis
- Nominal regenerative power
- Maximum regenerative power

Feedback into the supply grid is then not possible however. Regenerative power must be discharged by way of a braking resistor and converted into heat.

ATTENTION! **Dimensioning of braking resistor**
The braking resistor of the servocontroller should be dimensioned such that the total regenerative power of the multi-axis system can be dissipated.

DC link power and precharge capacitance of servocontroller

To gain an initial estimate as to whether a servocontroller is adequate to supply additional axis controllers, the power made available by the DC link of the servocontroller can be approximated using the following formulas:

$$P_{rated} = \sqrt{3} \cdot U_{mains} \cdot I_{rated\ (f_{sw}\ and\ U_{mains})} \cdot 0{,}8$$

$$P_{Max} = \sqrt{3} \cdot U_{mains} \cdot I_{Max\ (f_{sw}\ and\ U_{mains})} \cdot 0{,}8$$

In this, $I_{rated\ (fsw\ and\ Umains)}$ is the rated current and $I_{Max\ (fsw\ and\ Umains)}$ the maximum current of the servocontroller according to the switching frequency of the power stage and the mains voltage.

ATTENTION! **Do not exceed the maximum power**
The power values are quadratic means over a load cycle. The maximum power must not be exceeded at any time, and may only be tapped for the specified time, otherwise the servocontroller will be destroyed.

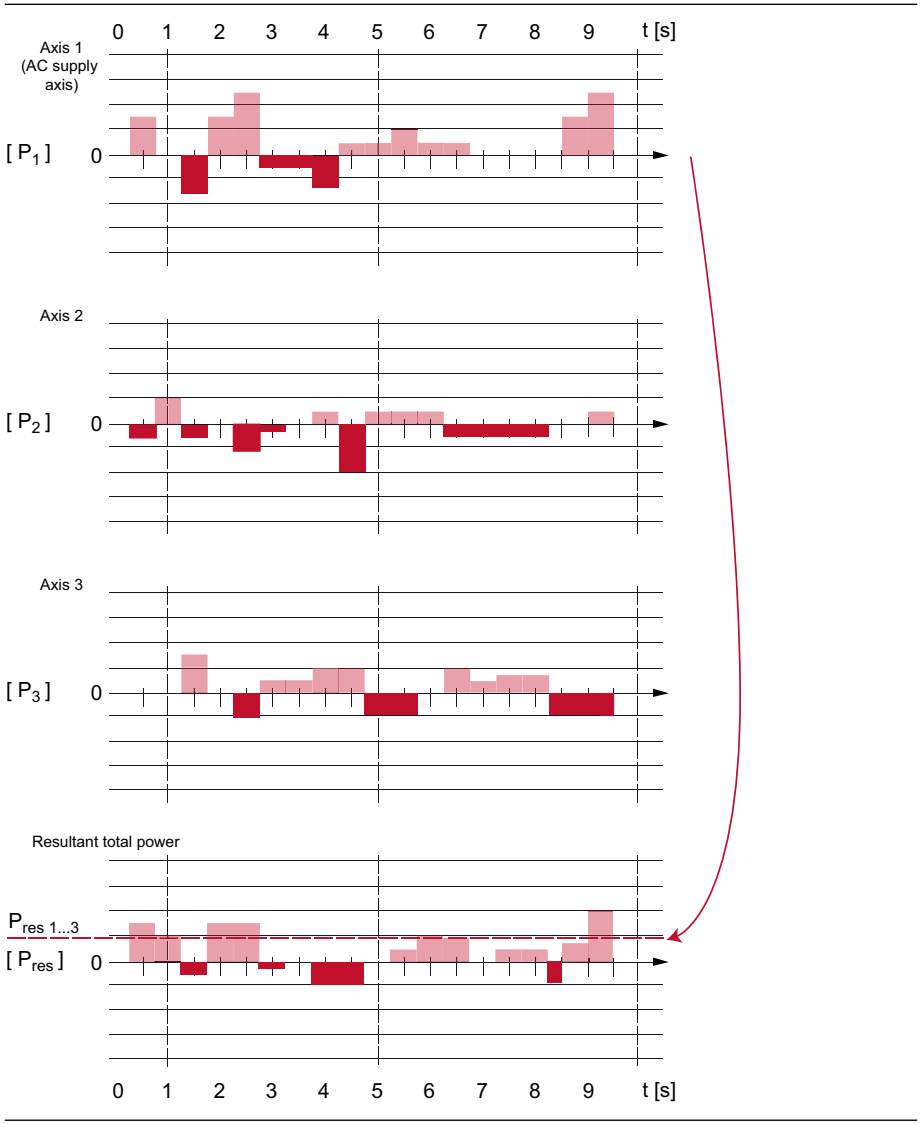


Figure A.4 Time/power graph with servocontroller as supply

In addition to the total power tap, the total DC link capacitance of the axis network also needs to be considered. The maximum precharge capacitance of the servocontroller must not be exceeded. In this regard refer to table A.6 and to table A.5 on page 69:

Servo-controller	DC link capacitance [µF]		Max.pre-charge capacitance [µF]
	Air cooling	Liquid cooling	
SO84.004.0	400	-	800 1)
SO84.006.0	400	-	800 1)
SO84.008.0	725	-	1450 1)
SO84.012.0	725	-	1450 1)
SO84.016.0	1230	1230	2040 1)
SO84.020.0	1230	1230	2040 1)
SO84.024.0	2000	2000	4000 1)
SO84.032.0	2000	2000	4000 1)
SO84.045.0	430	430	5100
SO84.060.0	900	900	5100
SO84.072.0	900	900	5100
SO84.090.0	1060	2120	9200
SO84.110.0	2120	2120	9200
SO84.143.0	3180	4240	9200
SO84.170.0	4240	4240	9200
SO84.250.0	-	3600	60000
SO84.325.0	-	5400	60000
SO84.450.0	-	7200	60000

1) Preliminary value

Table A.6 DC link capacitance and Maximum precharge capacitance of the servocontrollers

Calculation example: Feed from a servocontroller

Two DC axis controllers SO84.024.1, two DC axis controllers SO84.060.1 and one DC axis controller SO84.090.1 (air-cooled) are to be connected to a servocontroller SO84.170.0.

Calculation: 1 x 4240 µF + 2 x 504 µF + 2 x 900 µF + 1 x 1060 µF = 8108 µF

Result: The servocontroller is adequately dimensioned with a maximum pre-charge capacitance of 9200 µF.

NOTE: Note that not only the DC link capacitances of the DC axis controllers, but also of the supplying servocontroller, need to be considered.

A.7.7 External components

When using a servocontroller as the supply source you will need additional components:

- Mains filter
- Line reactor
- Braking resistor
- EMC fixings

See ServoOne system catalogue (ID no.: 1100.24B.x).

Release for field test only

Space for your own notes

B. Technical data

B.1 Current capacity of ServoOne DC axis controllers

The maximum permissible drive controller output current and the peak current are dependent on the DC supply voltage, the motor cable length, the power stage switching frequency and the ambient temperature. If the conditions change, the maximum permissible current capacity of the drive controllers also changes.

B.1.1 BG1 to BG4 (air-cooled, 400 V AC)

Type	Power stage switching frequency [kHz]	Ambient temperature [°C]	Rated current [A_{eff}]	Peak current[1] I_{MAX} 0 Hz [A_{eff}]	Peak current[1] I_{1MAX} ≥5 Hz [A_{eff}]	Peak current[1] t_1 [2] [s]	Peak current[1] I_{2MAX} ≥5 Hz [A_{eff}]	Peak current[1] t_2 [2] [s]
SO84.004.1xxx.0 (BG1)	4	40	5.3	8.4	8.4	10	11.9	0.5
	8		4.0	8.4	8.4		-	-
	12		3.7	6.6	6.6		-	-
	16		2.7	5.2	5.2		-	-
SO84.006.1xxx.0 (BG1)	4	40	8.0	12.7	12.7	10	18.0	0.5
	8		6.0	6.0	12.7		-	-
	12		5.5	9.9	9.9		-	-
	16		4.0	7.7	7.7		-	-
SO84.008.1xxx.0 (BG2)	4	40	9.3	15.9	15.9	10	23.9	0.5
	8		9.3	15.9	15.9		-	-
	12		6.7	9.4	9.4		-	-
	16		5.5	7.7	7.7		-	-
SO84.012.1xxx.0 (BG2)	4	40	14.0	24.0	24.0	10	36.0	0.5
	8		14.0	24.0	24.0		-	-
	12		10.0	14.1	14.1		-	-
	16		8.2	11.5	11.5		-	-
SO84.016.1xxx.0 (BG3)	4	40	20.0	33.6	33.6	10	48.0	0.5
	8		16.0	33.6	33.6		-	-
	12		11.0	23.6	23.6		-	-
	16		8.5	19.4	19.4		-	-
SO84.020.1xxx.0 (BG3)	4	40	25.0	42.0	42.0	10	60.0	0.5
	8		20.0	42.0	42.0		-	-
	12		13.8	29.6	29.6		-	-
	16		10.0	22.8	22.8		-	-
SO84.024.1xxx.0 (BG4)	4	40	30.0	48.0	48.0	10	72.0	0.5
	8		24.0	48.0	48.0		-	-
	12		15.8	31.6	31.6		-	-
	16		11.3	22.6	22.6		-	-
SO84.032.1xxx.0 (BG4)	4	40	40.0	64.0	64.0	10	96.0	0.5
	8		32.0	64.0	64.0		-	-
	12		21.0	42.0	42.0		-	-
	16		15.0	30.0	30.0		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.1 Rated and peak current, BG1 to BG4 (air-cooled, 400 V AC)

B.1.2 BG1 to BG4 (air-cooled, 460 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current[1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
SO84.004.1xxx.0 (BG1)	4	40	5.3	8.4	8.4	10	11.9	0.5
	8		3.4	7.2	7.2		-	-
	12		2.8	5.0	5.0		-	-
	16		1.9	3.6	3.6		-	-
SO84.006.1xxx.0 (BG1)	4	40	8.0	12.7	12.7	10	18.0	0.5
	8		5.1	10.8	10.8		-	-
	12		4.2	7.5	7.5		-	-
	16		2.9	5.6	5.6		-	-
SO84.008.1xxx.0 (BG2)	4	40	8.5	14.6	14.6	10	21.8	0.5
	8		6.7	11.5	11.5		-	-
	12		5.6	7.9	7.9		-	-
	16		4.1	5.8	5.8		-	-
SO84.012.1xxx.0 (BG2)	4	40	11.8	20.2	20.2	10	30.3	0.5
	8		10.0	17.1	17.1		-	-
	12		8.4	11.8	11.8		-	-
	16		6.2	8.7	8.7		-	-
SO84.016.1xxx.0 (BG3)	4	40	20.0	33.6	33.6	10	48.0	0.5
	8		13.9	29.1	29.1		-	-
	12		8.8	18.9	18.9		-	-
	16		6.5	14.8	14.8		-	-
SO84.020.1xxx.0 (BG3)	4	40	25.0	42.0	42.0	10	60.0	0.5
	8		17.4	36.5	36.5		-	-
	12		11.0	23.6	23.6		-	-
	16		7.4	16.8	16.8		-	-
SO84.024.1xxx.0 (BG4)	4	40	26.0	41.6	41.6	10	62.4	0.5
	8		21.0	42.0	42.0		-	-
	12		12.4	24.8	24.8		-	-
	16		8.9	17.8	17.8		-	-
SO84.032.1xxx.0 (BG4)	4	40	33.7	53.9	53.9	10	80.9	0.5
	8		28.0	56.0	56.0		-	-
	12		16.5	33.0	33.0		-	-
	16		11.9	23.8	23.8		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.2 Rated and peak current, BG1 to BG4 (air-cooled, 460 V AC)

B.1.3 BG1 to BG4 (air-cooled, 480 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current[1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
SO84.004.1xxx.0 (BG1)	4	40	5.3	8.4	8.4	10	11.9	0.5
	8		3.3	7.0	7.0		-	-
	12		2.7	4.8	4.8		-	-
	16		1.8	3.4	3.4		-	-
SO84.006.1xxx.0 (BG1)	4	40	8.0	12.7	12.7	10	18.0	0.5
	8		5.0	10.6	10.6		-	-
	12		4.0	7.2	7.2		-	-
	16		2.7	5.2	5.2		-	-
SO84.008.1xxx.0 (BG2)	4	40	8.5	14.6	14.6	10	21.8	0.5
	8		6.1	10.4	10.4		-	-
	12		5.4	7.6	7.6		-	-
	16		3.9	5.5	5.5		-	-
SO84.012.1xxx.0 (BG2)	4	40	11.4	19.5	19.5	10	29.3	0.5
	8		9.2	15.8	15.8		-	-
	12		8.1	11.4	11.4		-	-
	16		5.8	8.2	8.2		-	-
SO84.016.1xxx.0 (BG3)	4	40	20.0	33.6	33.6	10	48.0	0.5
	8		13.3	27.9	27.9		-	-
	12		8.5	18.3	18.3		-	-
	16		6.0	13.7	13.7		-	-
SO84.020.1xxx.0 (BG3)	4	40	25.0	42.0	42.0	10	60.0	0.5
	8		16.6	34.8	34.8		-	-
	12		10.0	21.5	21.5		-	-
	16		6.5	14.8	14.8		-	-
SO84.024.1xxx.0 (BG4)	4	40	26.0	41.6	41.6	10	62.4	0.5
	8		20.0	40.0	40.0		-	-
	12		11.3	22.6	22.6		-	-
	16		8.4	16.8	16.8		-	-
SO84.032.1xxx.0 (BG4)	4	40	32.5	52.0	52.0	10	78.0	0.5
	8		26.7	53.4	53.4		-	-
	12		15.0	30.0	30.0		-	-
	16		11.2	22.4	22.4		-	-

1) At max. 70 % preload
2) Shutdown as per I^2t characteristic
All data apply for motor cable length ≤10 m

Table B.3 Rated and peak current, BG1 to BG4 (air-cooled, 480 V AC)

B.1.4 BG1 to BG4 (air-cooled, 770 V DC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current[1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
SO84.004.1xxx.0 (BG1)	4	40	5.1	8.1	8.1	10	11.5	0.5
	8		3.2	6.8	6.8		-	-
	12		2.1	3.8	3.8		-	-
	16		1.1	2.1	2.1		-	-
SO84.006.1xxx.0 (BG1)	4	40	7.6	12.1	12.1	10	17.1	0.5
	8		4.8	10.2	10.2		-	-
	12		3.2	5.7	5.7		-	-
	16		1.6	3.1	3.1		-	-
SO84.008.1xxx.0 (BG2)	4	40	8.0	13.7	13.7	10	20.6	0.5
	8		5.9	10.1	10.1		-	-
	12		5.3	7.4	7.4		-	-
	16		3.7	5.2	5.2		-	-
SO84.012.1xxx.0 (BG2)	4	40	11.2	19.2	19.2	10	28.8	0.5
	8		8.8	15.1	15.1		-	-
	12		7.9	11.1	11.1		-	-
	16		5.5	7.7	7.7		-	-
SO84.016.1xxx.0 (BG3)	4	40	20.0	33.6	33.6	10	48.0	0.5
	8		11.2	23.5	23.5		-	-
	12		7.0	15.0	15.0		-	-
	16		4.5	10.2	10.2		-	-
SO84.020.1xxx.0 (BG3)	4	40	25.0	42.0	42.0	10	60.0	0.5
	8		14.0	29.4	29.4		-	-
	12		7.5	16.1	16.1		-	-
	16		5.0	11.4	11.4		-	-
SO84.024.1xxx.0 (BG4)	4	40	26.0	41.6	41.6	10	62.4	0.5
	8		18.9	37.8	37.8		-	-
	12		10.5	21.0	21.0		-	-
	16		7.9	15.8	15.8		-	-
SO84.032.1xxx.0 (BG4)	4	40	32.0	51.2	51.2	10	76.8	0.5
	8		25.2	50.4	50.4		-	-
	12		14.0	28.0	28.0		-	-
	16		10.5	21.0	21.0		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.4 Rated and peak current, BG1 to BG4 (air-cooled, 770 V DC)

B.1.5 BG5 and BG6a (air-cooled)

Type	Power stage switching frequency	Ambient temperature	Rated current				Peak current$_{eff}$] [1]			
			at 565 V_{DC} (400 V_{AC})[3]	at 650 V_{DC} (460 V_{AC})[3]	at 678 V_{DC} (480 V_{AC})[3]	at 770 V_{DC}	at linear-rising rotating field frequency 0 to 5 Hz		for intermittent operation	for time[2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO84.045.1xxx.0 (BG5)	4	40	45	42	41	41	90	90	90	3
	8		45	42	41	41	90	90	90	
	12		45	42	41	37	90	90	90	
	16		42	39	38	34	84	84	84	
SO84.060.1xxx.0 (BG5)	4	40	60	56	54	54	120	120	120	3
	8		60	56	54	54	120	120	120	
	12		58	54	52	48	116	116	116	
	16		42	39	38	34	84	84	84	
SO84.072.1xxx.0 (BG5)	4	40	72	67	65	65	144	144	144	3
	8		72	67	65	65	144	144	144	
	12		58	54	52	48	116	116	116	
	16		42	39	38	34	84	84	84	
SO84.090.1xxx.0 (BG6a)	4	40	90	83	81	73	170	180	180	10
	8		90	83	81	73	134	180	180	
	12		90	83	81	73	107	144	144	
	16		72	67	65	59	86	115	115	

1) When supplied with 565 VDC (corresponding to 400 V AC) at max. 70 % preload
2) Shutdown as per I²t characteristic
3) When supplied with AC servocontroller
All data apply for motor cable length ≤10 m

Table B.5 Rated and peak current, BG5 and BG6a (air-cooled)

Type	Power stage switching frequency	Ambient temperature	Rated current				Peak current$_{eff}$] [1]			
			at 565 V_{DC} (400 V_{AC})[3]	at 650 V_{DC} (460 V_{AC})[3]	at 678 V_{DC} (480 V_{AC})[3]	at 770 V_{DC}	at linear-rising rotating field frequency 0 to 5 Hz		for intermittent operation	for time[2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO84.110.1xxx.0 (BG6a)	4	40	110	102	99	90	170	220	220	10
	8		110	102	99	90	134	165	165	
	12		90	83	81	73	107	144	144	
	16		72	67	65	59	86	115	115	
SO84.143.1xxx.0 (BG6a)	4	40	143	132	129	116	190	286	286	10
	8		143	132	129	116	151	215	215	
	12		115	106	104	94	121	172	172	
	16		92	85	83	75	97	138	138	
SO84.170.1xxx.0 (BG6a)	4	40	170	157	153	138	190	315	315	10
	8		170	157	153	138	151	220	220	
	12		136	126	122	110	121	164	164	
	16		109	101	98	88	97	131	131	

1) When supplied with 565 VDC (corresponding to 400 V AC) at max. 70 % preload
2) Shutdown as per I²t characteristic
3) When supplied with AC servocontroller
All data apply for motor cable length ≤10 m

Table B.5 Rated and peak current, BG5 and BG6a (air-cooled)

B.1.6 BG3 and BG4 (liquid-cooled, 400 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current[1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
SO84.016.1xxx.8 (BG3)	4	40	20.0	33.6	33.6	10	48.0	0.5
	8		20.0	33.6	33.6		-	-
	12		17.4	26.4	26.4		-	-
	16		12.0	18.2	18.2		-	-
SO84.020.1xxx.8 (BG3)	4	40	25.0	42.0	42.0	10	60.0	0.5
	8		25.0	42.0	42.0		-	-
	12		21.8	33.1	33.1		-	-
	16		15.0	22.8	22.8		-	-
SO84.024.1xxx.8 (BG4)	4	40	30.0	48.0	48.0	10	72.0	0.5
	8		26.3	48.1	48.1		-	-
	12		22.5	31.5	31.5		-	-
	16		16.1	22.5	22.5		-	-
SO84.032.1xxx.8 (BG4)	4	40	40.0	64.0	64.0	10	96.0	0.5
	8		35.0	64.0	64.0		-	-
	12		30.0	42.0	42.0		-	-
	16		21.4	29.9	29.9		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.6 Rated and peak current, BG3 and BG4 (liquid-cooled, 400 V AC)

B.1.7 BG3 and BG4 (liquid-cooled, 460 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current[1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
SO84.016.1xxx.8 (BG3)	4	40	20.0	33.6	33.6	10	48.0	0.5
	8		17.4	29.2	29.2		-	-
	12		12.5	19.0	19.0		-	-
	16		9.1	13.8	13.8		-	-
SO84.020.1xxx.8 (BG3)	4	40	25.0	42.0	42.0	10	60.0	0.5
	8		21.8	36.6	36.6		-	-
	12		15.6	23.7	23.7		-	-
	16		11.4	17.3	17.3		-	-
SO84.024.1xxx.8 (BG4)	4	40	26.0	41.6	41.6	10	62.4	0.5
	8		23.0	42.0	42.0		-	-
	12		17.7	24.8	24.8		-	-
	16		12.8	17.9	17.9		-	-
SO84.032.1xxx.8 (BG4)	4	40	33.7	53.9	53.9	10	80.9	0.5
	8		30.6	55.9	55.9		-	-
	12		23.6	33.0	33.0		-	-
	16		17.0	23.8	23.8		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.7 Rated and peak current, BG3 and BG4 (liquid-cooled, 460 V AC)

B.1.8 BG3 and BG4 (liquid-cooled, 480 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current[1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
SO84.016.1xxx.8 (BG3)	4	40	20.0	33.6	33.6	10	48.0	0.5
	8		16.6	27.9	27.9		-	-
	12		11.4	17.3	17.3		-	-
	16		8.5	12.9	12.9		-	-
SO84.020.1xxx.8 (BG3)	4	40	25.0	42.0	42.0	10	60.0	0.5
	8		20.8	34.9	34.9		-	-
	12		14.3	21.7	21.7		-	-
	16		10.6	16.1	16.1		-	-
SO84.024.1xxx.8 (BG4)	4	40	26.0	41.6	41.6	10	62.4	0.5
	8		21.9	40.0	40.0		-	-
	12		16.1	22.5	22.5		-	-
	16		12.0	16.8	16.8		-	-
SO84.032.1xxx.8 (BG4)	4	40	32.5	52.0	52.0	10	78.0	0.5
	8		29.2	53.4	53.4		-	-
	12		21.4	30.0	30.0		-	-
	16		16.0	22.4	22.4		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.8 Rated and peak current, BG3 and BG4 (liquid-cooled, 480 V AC)

B.1.9 BG3 and BG4 (liquid-cooled, 770 V DC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current[1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
SO84.016.1xxx.8 (BG3)	4	40	20.0	33.6	33.6	10	48.0	0.5
	8		15.8	26.5	26.5		-	-
	12		10.7	16.2	16.2		-	-
	16		8.1	12.3	12.3		-	-
SO84.020.1xxx.8 (BG3)	4	40	25.0	42.0	42.0	10	60.0	0.5
	8		19.8	33.2	33.2		-	-
	12		13.4	20.3	20.3		-	-
	16		10.1	15.3	15.3		-	-
SO84.024.1xxx.8 (BG4)	4	40	26.0	41.6	41.6	10	62.4	0.5
	8		20.7	37.8	37.8		-	-
	12		15.4	21.5	21.5		-	-
	16		11.3	15.8	15.8		-	-
SO84.032.1xxx.8 (BG4)	4	40	32.0	51.2	51.2	10	76.8	0.5
	8		27.6	50.5	50.5		-	-
	12		20.5	28.7	28.7		-	-
	16		15.0	21.0	21.0		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.9 Rated and peak current, BG3 and BG4 (liquid-cooled, 770 V DC)

B.1.10 BG5 and BG6a (liquid-cooled)

Type	Power stage switching frequency	Ambient temperature	Rated current				Peak current$_{eff}$] [1]			
			at 565 V_{DC} (400 V_{AC})[3]	at 650 V_{DC} (460 V_{AC})[3]	at 678 V_{DC} (480 V_{AC})[3]	at 770 V_{DC}	at linear-rising rotating field frequency 0 to 5 Hz		for intermittent operation	for time[2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO84.045.1xxx.8 (BG5)	4	40	53	49	48	48	90	90	90	3
	8		53	49	48	48	90	90	90	
	12		53	49	48	42	90	90	90	
	16		49	45	44	39	84	84	84	
SO84.060.1xxx.8 (BG5)	4	40	70	65	63	63	120	120	120	3
	8		70	65	63	63	120	120	120	
	12		68	63	61	55	116	116	116	
	16		49	45	44	39	84	84	84	
SO84.072.1xxx.8 (BG5)	4	40	84	78	76	76	144	144	144	3
	8		84	78	76	76	144	144	144	
	12		68	63	61	55	116	116	116	
	16		49	45	44	39	84	84	84	
SO84.090.1xxx.8 (BG6a)	4	40	110	102	99	90	205	220	220	10
	8		110	102	99	90	165	187	187	
	12		110	102	99	90	132	165	165	
	16		90	83	81	73	106	135	135	
SO84.110.1xxx.8 (BG6a)	4	40	143	132	129	116	230	286	286	10
	8		143	132	129	116	190	215	215	
	12		114	105	103	93	152	172	172	
	16		91	84	82	74	122	138	138	
SO84.143.1xxx.8 (BG6a)	4	40	170	157	153	138	230	340	340	10
	8		170	157	153	138	190	255	255	
	12		136	126	122	110	152	204	204	
	16		109	101	98	88	122	163	163	
SO84.170.1xxx.8 (BG6a)	4	40	210	194	189	170	230	340	340	10
	8		210	194	189	170	190	255	255	
	12		168	155	151	136	152	204	204	
	16		134	124	121	109	122	163	163	

1) When supplied with 565 VDC (corresponding to 400 V AC) at max. 70 % preload
2) Shutdown as per I²t characteristic
3) When supplied with AC servocontroller
All data apply for motor cable length ≤10 m

Table B.10 Rated and peak current, BG5 and BG6a (liquid-cooled)

B.2 Technical data – ServoOne DC axis controllers

B.2.1 SO82.004 to SO84.020

Technical data \ Designation		SO84.004	SO84.006	SO84.008	SO84.012	SO84.016	SO84.020
Output, motor side [1]							
Voltage		3-phase $U_{ZK}/\sqrt{2}$					
Rated current, effective (I_N)	Air cooling	4 A	6 A	8 A	12 A	16 A	20 A
	Liquid cooling	-	-	-	-	20 A	25 A
Peak current	Air cooling	see tables B.1 to B.4					
	Liquid cooling	-	-	-	-	Tables B.6 to B.9	
Rotating field frequency		0 ... 400 Hz					
Power stage switching frequency		4, 8, 12, 16 kHz					
DC input							
DC voltage (U_{ZK}) nominal [2]		565 V_{DC} / 650 V_{DC} / 679 V_{DC} / 770 V_{DC}					
Current (RMS approximation value)		1.7 · I_{motor}					
Device connected load [3]		U_{ZK} · 1.7 · I_{motor}					
Power loss at I_N and 8 kHz/ 565 V DC [3]	Air cooling	110 W	140 W	185 W	255 W	320 W	390 W
	Liquid cooling	-	-	-	-	390 W	480 W
DC link							
DC link capacity		60 µF		105 µF		288 µF	

1) *All data referred to output voltage 400 V_{eff} and switching frequency 8 kHz*
2) *Generated from rectified TN system with grounded neutral point and external conductor voltages 3 x 400 V AC, 3 x 460 V AC or 3 x 480 V AC with the approved LTi DRiVES devices (ServoOne AC axis controller or supply unit). Insulation voltage as per EN 61800-5-1, system voltage 277 V, overvoltage category III.*
3) *Approximate values*

Table B.11 Technical data – SO84.004 to SO84.020

B.2.2 SO84.024 to SO84.060

Technical data \ Designation		SO84.024	SO84.032	SO84.045	SO84.060
Output, motor side [1]					
Voltage		3-phase $U_{ZK}/\sqrt{2}$			
Rated current, effective (I_N)	Air cooling	24 A	32 A	45 A	60 A
	Liquid cooling	30 A	40 A	53 A	70 A
Peak current	Air cooling	see tables B.1 to B.4		see table B.5	
	Liquid cooling	see tables B.6 to B.9		see table B.10	
Rotating field frequency		0 ... 400 Hz			
Power stage switching frequency		4, 8, 12, 16 kHz			
DC input					
DC voltage (U_{ZK}) nominal [2]		565 V_{DC} / 650 V_{DC} / 679 V_{DC} / 770 V_{DC}			
Current (RMS approximation value)		1.7 · I_{motor}			
Device connected load		U_{ZK} · 1.7 · I_{motor}			
Power loss at I_N and 8 kHz/ 565 V DC [3]	Air cooling	420 W	545 W	610 W	830 W
	Liquid cooling	455 W	595 W	690 W	930 W
DC link					
DC link capacity	Air cooling	504 µF		430 µF	900 µF
	Liquid cooling			900 µF	

1) *All data referred to output voltage 400 V_{eff} and switching frequency 8 kHz*
2) *Generated from rectified TN system with grounded neutral point and external conductor voltages 3 x 400 V AC, 3 x 460 V AC or 3 x 480 V AC with the approved LTi DRiVES devices (ServoOne AC axis controller or supply unit). Insulation voltage as per EN 61800-5-1, system voltage 277 V, overvoltage category III.*
3) *Approximate values*

Table B.12 Technical data – SO84.024 to SO84.060

B.2.3 SO84.072 to SO84.170

Technical data \ Designation		SO84.072	SO84.090	SO84.110	SO84.143	SO84.170
Output, motor side [1]						
Voltage		3-phase $U_{ZK}/\sqrt{2}$				
Rated current, effective (I_N)	Air cooling	72 A	90 A	110 A	143 A	170 A
	Liquid cooling	84 A	110 A	143 A	170 A	210 A
Peak current	Air cooling	see table B.5				
	Liquid cooling	see table B.10				
Rotating field frequency		0 ... 400 Hz				
Power stage switching frequency		4, 8, 12, 16 kHz				
DC input						
DC voltage (U_{ZK}) nominal [2]		565 V_{DC} / 650 V_{DC} / 679 V_{DC} / 770 V_{DC}				
Current (RMS approximation value)		1.2 · I_{motor}				
Device connected load [3]		U_{ZK} · 1.2 · I_{motor}				
Power dissipation at I_N and 8 kHz/ 565 V DC	Air cooling	1010 W	1300 W	1600 W	2100 W	2500 W
	Liquid cooling	1130 W	1500 W	1940 W	2380 W	2650 W
DC link						
DC link capacity	Air cooling	900 µF	1060 µF	2120 µF	3180 µF	4240 µF
	Liquid cooling		2120 µF	3180 µF	4240 µF	

1) *All data referred to output voltage 400 V_{eff} and switching frequency 8 kHz*

2) *Generated from rectified TN system with grounded neutral point and external conductor voltages 3 x 400 V AC, 3 x 460 V AC or 3 x 480 V AC with the approved LTi DRiVES devices (ServoOne AC axis controller or supply unit). Insulation voltage as per EN 61800-5-1, system voltage 277 V, overvoltage category III.*

3) *Approximate values*

Table B.13 Technical data – SO84.090 to SO84.170

B.3 Motor cable terminals

Feature	BG1 + BG2	BG3 + BG4	BG5	BG6a	
				90 - 110 A	143 - 170 A
Cable connection capability (flexible, with ferrule)	0.25 - 4 mm² (AWG 24 - AWG 10) *)	0.75 - 16 mm² (AWG 18 - AWG 6)	max. 25 mm² (AWG 4)	35 - 95 mm² (AWG 2 - AWG 4/0)	50 - 150 mm² (AWG 3 - AWG 5/0)
Tightening torque (Nm)	0.7 - 0.8	1.7 - 1.8	2.5 - 4.5	15 - 20	25 - 30
Recommended crimping tool	Phoenix CRIMPFOX 6	Phoenix CRIMPFOX 6 or 16 S	Phoenix CRIMPFOX or similar	-	-

*) *With ferrule without plastic sleeve up to 6 mm² possible*

Table B.14 Technical data – motor terminals BG1 to BG6a

B.4 Current consumption of control supply

Housing variant	Size	Max. startup current	Continuous current
Wall mounting	BG1 - BG4	6 A	2 A
	BG5	7 A	2.5 A
	BG6a	10 A	8 A
Liquid cooling	BG3 - BG4	6 A	2 A
	BG5	7 A	2 A
	BG6a	8 A	2 A

Table B.15 Current consumption of control supply

B.5 Ready made-up cables

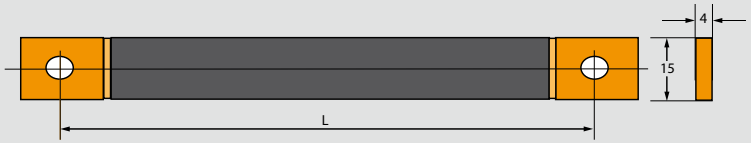
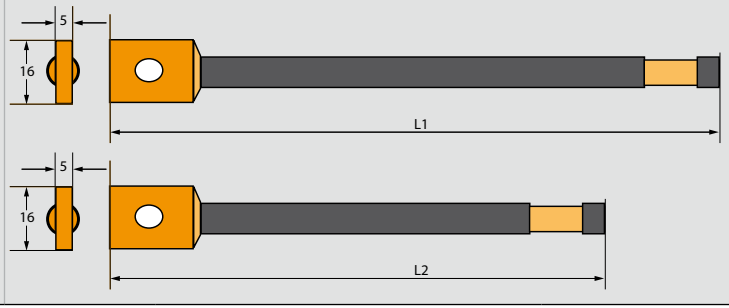
Type	L	Cross-section	Variant	Connection
DC link BG1	61.5 mm	42 mm²	Flat copper braiding with double shrink-fit tube covering	Flat sheath on both sides with hole Ø 5.5 mm
DC link BG2	93 mm	42 mm²		
DC link BG3	133 mm	42 mm²		
DC link BG4	174 mm	42 mm²		
DC link BG5	193 mm	42 mm²		
Sketch				
DC link BG6a	L1 = 385 mm L2 = 345 mm	30 mm²	Round stranded copper with double shrink-fit tube covering	One side flat sheath with hole Ø 5.5 mm, second side stripped strand
Sketch				

Table B.16 Technical data – ready made-up encoder cables

Cable connections

Supply		Axis controller to connect: BG1 BG2	BG3 BG4	BG5	BG6a
Supply unit BG5 *or* DC axis controller BG1 to BG5	Cable	Use only the ready made-up cables supplied.			-
	Tightening torque (Nm)	2.5			-
Supply unit BG6a	Cable	Use only the ready made-up cables supplied.			95 mm² (AWG 4/0)
	Tightening torque (Nm)	2.5			20
AC servocontroller	Cable	6 mm² (AWG 9), max. 1 m	16 mm² (AWG 5), max. 1 m	35 mm² (AWG 2)	95 mm² (AWG 4/0)
		On one side ring cable lug [1] with hole Ø 5.3 mm.			
	Tightening torque (Nm)	2.5			20

1) *In the case of ring cable lugs without insulation, the crush zone and min. 20 mm of the cable insulation should be insulated fully with heat-shrink tubing.*

Table B.17 Cables, cross-sections and tightening torques

ATTENTION! **Requirements for longer cables**

- Use only the ready made-up cables supplied for the DC electrical connections between the devices.
- If extending the cable is unavoidable (such as to bypass a switch cabinet panel or for a second DC axis controller array), the DC link connection must be made as follows:
  - Cable cross-section >30 mm² (copper)
  - A PE conductor of the same cross-section should run alongside and be connected to the PE terminals of the two interconnected devices.
  - The three conductors (DC+, DC-, PE) should be bundled and shielded.
  - A length of 2 metres must not be exceeded.
  - Only **one** extension may be executed in each multi-axis system.

B.6 Ambient conditions

Ambient conditions	ServoOne DC axis controller
Protection	IP20 except terminals (IP00)
Accident prevention regulations	according to local regulations (in Germany e.g. BGV A3)
Mounting height	up to 1000 m above MSL, above with power reduction (1 % per 100 m, max. 2000 m above MSL)
Pollution severity	2
Type of installation	Built-in unit, only for vertical installation in a switch cabinet with min. IP4xprotection; when using the STO safety function min. IP54

Table B.18 ServoOne ambient conditions

Climatic conditions		ServoOne DC axis controller
in transit	as perEN 61800-2, IEC 60721-3-2 class 2K3[1]	
	Temperature	-25 °C to +70 °C
	Relative humidity	95 % at max. +40 °C
in storage	as per EN 61800-2, IEC 60721-3-1 class 1K3 and 1K4[2]	
	Temperature	-25 °C to +55 °C
	Relative humidity	5 to 95 %
in operation	as per EN 61800-2, IEC 60721-3-3 class 3K3[3]	
	Temperature	**BG1** -10 °C to +40 °C (4, 8, 12, 16 kHz) **BG2-4** -10 °C to +45 °C (4 kHz), to 55 °C with power reduction (5 %/°C) -10 °C to +40 °C (8, 12, 16 kHz), to 55 °C with power reduction (4 %/°C) **BG5+6a** -10 °C to +40 °C (4, 8, 12, 16 kHz), to 55 °C with power reduction (2 %/°C)
	Relative humidity	5 to 85 % without condensation

1) *The absolute humidity is limited to max. 60 g/m³. This means, at 70 °C for example, that the relative humidity may only be max. 40 %.*

2) *The absolute humidity is limited to max. 29 g/m³. So the maximum values for temperature and relative humidity stipulated in the table must not occur simultaneously.*

3) *The absolute humidity is limited to max. 25 g/m³. That means that the maximum values for temperature and relative humidity stipulated in the table must not occur simultaneously.*

Table B.19 ServoOne climatic conditions

Mechanical conditions	ServoOne DC axis controller		
Vibration limit in transit	as per EN 61800-2, IEC 60721-3-2 class 2M1		
	Frequency [Hz]	Amplitude [mm]	Acceleration [m/s²]
	2 ≤ f < 9	3.5	Not applicable
	9 ≤ f < 200	Not applicable	10
	200 ≤ f < 500	Not applicable	15
Shock limit in transit	as per EN 61800-2, IEC 60721-2-2 class 2M1		
	Drop height of packed device max. 0.25 m		
Vibration limits of the system[1]	as per EN 61800-2, IEC 60721-3-3 class 3M1		
	Frequency [Hz]	Amplitude [mm]	Acceleration [m/s²]
	2 ≤ f < 9	0.3	Not applicable
	9 ≤ f < 200	Not applicable	1

1) *Note: The devices are only designed for stationary use.*

Table B.20 ServoOne mechanical conditions

ATTENTION!

- **Switch cabinet**
  According to EN ISO 13849-2, when using the STO (Safe Torque OFF) safety function the switch cabinet STO must have IP54 protection or higher.
- **Vibration**
  The drive controllers must not be installed in areas where they would be permanently exposed to vibrations.

B.7 Hydrological data of liquid cooling

ATTENTION! The temperature of the cooling plate must not be more than 10 °C below the ambient temperature. Condensation will result in destruction of the device.

NOTE: Customers must provide adequate heat dissipation for the water cooler. The coolant should be approved by LTi DRiVES if it deviates from the following requirements:

Requirements		Limits
Coolant quality		Recommended: Drinking water + corrosion inhibitor (e.g. ethylene glycol) Not permitted: Chloride ions (Cl- > 100 ppm) Calcium carbonate (CaCO3 > 160 ppm)
Pollution		The coolant must be as pure as possible so as not to clog the ducts. At a suspension concentration above 15 mg/dm³ continuous cleaning is recommended.
Operating coolant temperature		The coolant temperature may be between 5 °C and 40 °C. However, the coolant temperature must not be more than 10 °K below the ambient temperature, so as to prevent condensation on the heat sink.
Cooler material		Aluminium
Coolant pressure (nominal/maximum value)		1 bar / 2 bar [1)]
Coolant flow rate (nominal/maximum value)	BG3 - BG4	3 l per min / 4 l per min [1)]
	BG5	8 l per min / 11 l per min [1)]
	BG6a	11 l per min / 13 l per min [1)]

1) Preliminary data

Table B.21 Liquid cooling requirements

B.8 Dynamic cooler temperature monitoring

If the coolant flow breaks down or is not generated, the power stage may overheat. For this reason the drive controller is fitted with a dynamic cooler temperature monitor which shuts off the drive controller in the event of overheating. The drive controller shuts down at a heat sink temperature of 65 °C regardless of the temperature gradient.

B.9 UL approbation

UL approbation of the ServoOne multi-axis system is in work.

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C. Application example

C.1 Supply unit/DC axis controller lock

The following example presents a means of configuring the ServoOne supply unit with the ServoOne DC axis controllers used in the multi-axis system such that in the event of a fault the complete multi-axis system is shut down.

Normally in regenerative mode the DC axis controllers feed power back via the supply unit into the public grid. In the event of failure of the supply unit or of the public grid, the power is routed into the braking resistor. To protect against overloading of the braking chopper of the supply unit, the supply unit can be configured in conjunction with the DC axis controllers as follows. As soon as the supply unit is no longer actively controlling, the DC axis controllers' power stage enable (ENPO) is cancelled.

Step	Action	Comment
1.	Wire the supply unit with the connected DC axis controllers as shown in figure C.1.	
2.	Assign supply unit output REL (X4/23,24) the "Control in function" function (value 2, OUTPUT_FS_ACTIV).	For more functions refer to the ServoOne supply unit operation manual.

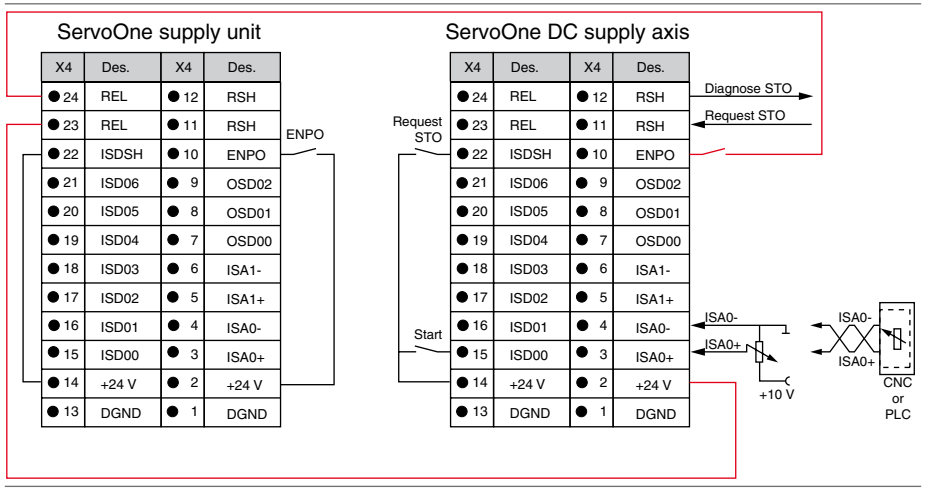

Figure C.1 ServoOne multi-axis system lock

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We reserve the right to make technical changes

The content of our documentation was compiled with the greatest care and attention, and based on the latest information available to us.

We should nevertheless point out that this document cannot always be updated in line with ongoing technical developments in our products.

Information and specifications may be subject to change at any time. For information on the latest version please visit http://drives.lt-i.com.

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Applicable as from firmware version: V2.20-01 - Release for field test only!

The German version is the original of this Operation Manual.

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